Comm No: 246040

Project Manual I

Divisions 00 - 32

Nelson Care Center Renovation

Vivie

Alexandria, Minnesota

Book 1 of 1

Wold Architects and Engineers
50 South 6th Street, Suite 2250
Minneapolis, MN 55402
woldae.com | 612 772 9025

PLANNERS
ARCHITECTS
ENGINEERS

SECTION 00 01 01
PROJECT TITLE PAGE

P R O J E C T M A N U A L

PROJECT IDENTIFICATION

BIDDING REQUIREMENTS

CONDITIONS OF THE CONTRACT

GENERAL REQUIREMENTS

AND SPECIFICATIONS

FOR

Nelson Care Center Renovation
420 Twelfth Avenue East
Alexandria, Minnesota 56308

Vivie
2209 Jefferson Street, Suite 201
Alexandria, Minnesota 56308

ISSUE DATE: August 29, 2025

END OF SECTION 00 01 01

SECTION 00 01 03
PROJECT DIRECTORY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Identification of project team members and their contact information.

1.02 OWNER:

A. Name: Vivie
   1. Address: 2209 Jefferson Street, Suite 201, Alexandria, Minnesota 56308

1.03 CONSULTANTS:

A. Architect:
   1. Company Name: Wold Architects and Engineers
      a. Address: 50 South Sixth Street, Suite 2250, Minneapolis, Minnesota 55402
      b. Telephone: (612) 772-9025

B. Civil Engineering Consultant:
   1. Company Name: Hagstrom Engineering
      a. Address: 219 Sixth Avenue East, Alexandria, Minnesota
      b. Telephone: (320) 759-0764

C. Structural Engineering Consultant:
   1. Company Name: BKBM Engineers
      a. Address: 6120 Earle Brown Drive, Suite 700, Minneapolis, Minnesota 55430
      b. Telephone: (763) 843-0420

D. Mechanical Engineering Consultant:
   1. Company Name: Wold Architects and Engineers
      a. Address: 50 South Sixth Street, Suite 2250, Minneapolis, Minnesota 55402
      b. Telephone: (612) 772-9025

E. Electrical Engineering Consultant:
   1. Company Name: Wold Architects and Engineers
      a. Address: 50 South Sixth Street, Suite 2250, Minneapolis, Minnesota 55402
      b. Telephone: (612) 772-9025

1.04 CONSTRUCTION MANAGER:

A. Company Name: Innovative Builders, Inc.
   1. Address: 221 30th Avenue West, Alexandria, Minnesota 56308
   2. Telephone: (320) 763-8900

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 00 01 03

SECTION 00 01 05
CERTIFICATIONS PAGE
Nelson Care Center Renovation
Vivie

Architect: Wold Architects and Engineers

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Architect under the laws of the State of Minnesota.

Signature: _____
Typed Name: Sara Malin
Registration: 40063
Date Signed: August 29, 2025

Civil Engineer: Hagstrom Engineering

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: _____
Typed Name: Matthew R. Hagstrom
Registration: 50731
Date Signed: August 29, 2025

Structural Engineer: BKBM Engineers

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: _____
Typed Name: Marie G. DesHarnais
Registration: 55419
Date Signed: August 29, 2025

Mechanical Engineer: Wold Architects and Engineers

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: _____
Typed Name: Brian Evan
Registration: 54354
Date Signed: August 29, 2025

Electrical Engineer: Wold Architects and Engineers

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: _____
Typed Name: Sitha Chhum
Registration: 54883
Date Signed: August 29, 2025

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SECTION 00 01 10

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Innovative
Builders · Erectors · Developers

00 11 13 - ADVERTISEMENT FOR BID

August 29, 2025

PROJECT: Vivie Nelson Care Center Remodel, Alexandria MN

PROJECT SCOPE: Three Phase Renovation Project for Vivie Nelson Care Center in Alexandria, MN.

BID DATE: Thursday September 25, 2025 @ 2:00 PM

PRE-BID WALKTHROUGH: Tuesday September 16, 2025 @ 2:00 PM

ACCEPTING BIDS FOR: All sections of work except Demolition, Concrete Labor, Steel Erection, Rough & Finish Carpentry Labor, and Shingle Roofing Labor will be self-performed by Innovative Builders.

SCHEDULE: Project will start January 5, 2026, with the completion of June 4, 2027. See milestone schedule in section 00 31 13 for estimated start and completion timeframes for each phase.

SALES TAX EXEMPT: Vivie Senior Living is a tax-exempt organization. Materials purchased for this project will be purchased "Tax Exempt". Please provide labor and materials bids.

BID BOND: Not Required.

Subcontractors and material suppliers are invited to send bids (using your own bid forms) to Innovative Builders, Inc. until **Thursday, September 25, 2025 @ 2:00 PM**. All proposals shall be presented to Innovative Builders, Inc., located at 221 30th Avenue West, Alexandria, MN 56308. Bids can also be faxed to Innovative at (320) 763-8905 or emailed to bids@innovativecompaniesinc.com. **The Bids email address is for bids only**. DO NOT SEND INQUIRES TO THE BIDS EMAIL AS THEY WILL NOT BE RESPONDED TO. Any project inquires can be directed to the Project Manager Scott Kluver at 320-763-8900 or emailed to scott@innovativecompaniesinc.com.

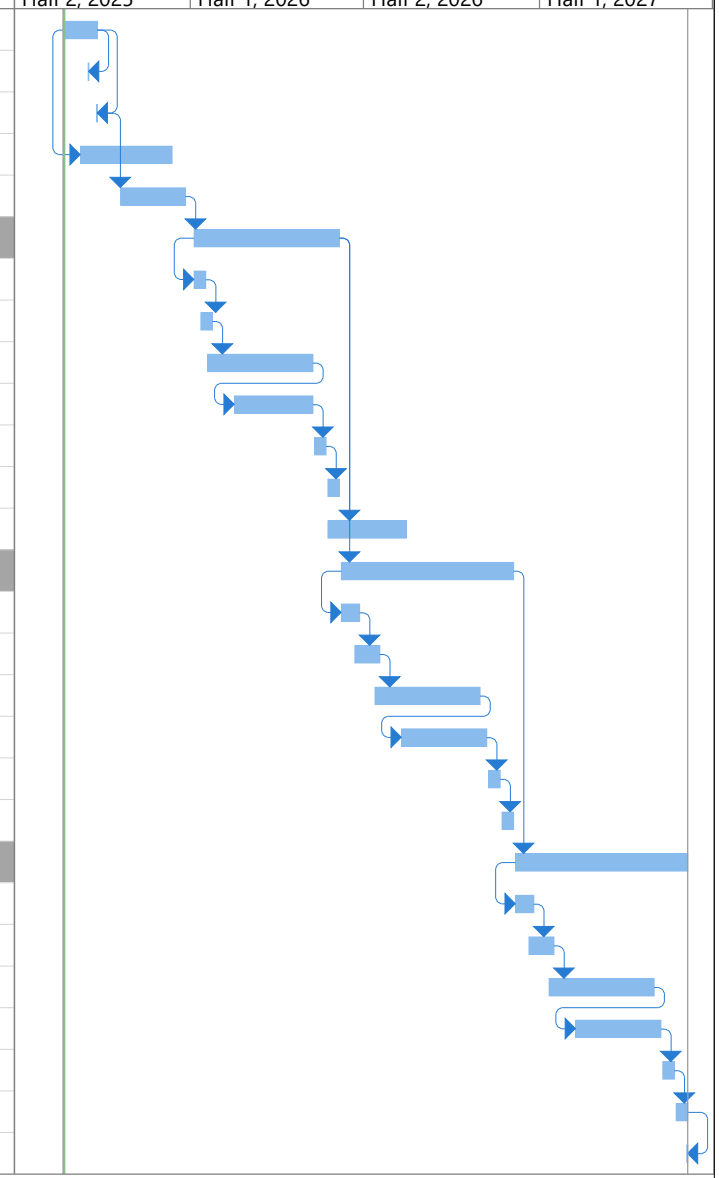
Bidding Documents
Plans will be available for viewing at Innovative Builders office located at 221 30th Avenue West in Alexandria or on-line from our web site (see instructions below).

Innovative's web site plan download instructions:
Go to www.innovativecompaniesinc.com. Click on the words "plan room" in the upper right hand portion of the page. Enter **"vivie@innovative.com"** as the user name and "**In2plans**" as the password, and then click on login. Next, the window will update showing the file directory, just click on the file to enter the directory. Once in the directory, click in the box to the left of the files you wish to download, and then click on the Red download button on the right hand side. After a brief period (depending on your internet speed), another window will open asking if you want to open, save or save as (this may vary depending on your web browser type and version). Please save or save as to your local computer. The website will be updated as addendums become available.

No bidder may withdraw his bid within 60 days after the set bid date.

Milestone Schedule | Vivie Nelson Care Center Renovation | August 21, 2025

ID	Task Name	Duration	Start	Finish
1	Bid Phase	26 days	Thu 8/21/25	Thu 9/25/25
2	Pre-Bid Site Meeting 2:00PM	1 day	Tue 9/16/25	Tue 9/16/25
3	Bids Due 2:00PM	1 day	Thu 9/25/25	Thu 9/25/25
4	State Approvals	70 days	Mon 9/8/25	Fri 12/12/25
5	Shop Drawings & Material Procurement	50 days	Mon 10/20/25	Fri 12/26/25
6	**Phase 1 - Short Term Stay**	**110 days**	**Mon 1/5/26**	**Fri 6/5/26**
7	Selective Demolition	10 days	Mon 1/5/26	Fri 1/16/26
8	Framing	10 days	Mon 1/12/26	Fri 1/23/26
9	Mechanical & Electrical	80 days	Mon 1/19/26	Fri 5/8/26
10	Drywall & Finishes	60 days	Mon 2/16/26	Fri 5/8/26
11	Punch List / Final Inspections	10 days	Mon 5/11/26	Fri 5/22/26
12	Owner Move In	10 days	Mon 5/25/26	Fri 6/5/26
13	Exterior Canopy & Parking Lot Construction	60 days	Mon 5/25/26	Fri 8/14/26
14	**Phase 2 - Maples**	**130 days**	**Mon 6/8/26**	**Fri 12/4/26**
15	Selective Demolition	15 days	Mon 6/8/26	Fri 6/26/26
16	Framing	20 days	Mon 6/22/26	Fri 7/17/26
17	Mechanical & Electrical	80 days	Mon 7/13/26	Fri 10/30/26
18	Drywall & Finishes	65 days	Mon 8/10/26	Fri 11/6/26
19	Punch List / Final Inspections	10 days	Mon 11/9/26	Fri 11/20/26
20	Owner Move In	10 days	Mon 11/23/26	Fri 12/4/26
21	**Phase 3 - Pines**	**130 days**	**Mon 12/7/26**	**Fri 6/4/27**
22	Selective Demolition	15 days	Mon 12/7/26	Fri 12/25/26
23	Framing	20 days	Mon 12/21/26	Fri 1/15/27
24	Mechanical & Electrical	80 days	Mon 1/11/27	Fri 4/30/27
25	Drywall & Finishes	65 days	Mon 2/8/27	Fri 5/7/27
26	Punch List / Final Inspections	10 days	Mon 5/10/27	Fri 5/21/27
27	Owner Move In	10 days	Mon 5/24/27	Fri 6/4/27
28	Final Completion	1 day	Fri 6/4/27	Fri 6/4/27



Innovative Builders, Inc.

SECTION 00 72 00
GENERAL CONDITIONS

The "General Conditions of the Contract for Construction", AIA Document A201, Sixteenth Edition, 2017 is attached after this section.

END OF SECTION 00 72 00

AIA® Document A201® – 2017

General Conditions of the Contract for Construction

for the following PROJECT:
(Name and location or address)

Nelson Care Center Renovation
420 Twelfth Avenue East
Alexandria, Minnesota 56308

THE OWNER:
(Name, legal status and address)

Vivie
2209 Jefferson Street, Suite 201
Alexandria, Minnesota 56308

THE ARCHITECT:
(Name, legal status and address)

Wold Architects and Engineers
50 South Sixth Street, Suite 2250
Minneapolis, Minnesota 55402
Telephone Number: 612-772-9025

ADDITIONS AND DELETIONS:
The author of this document may have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™–2017, Guide for Supplementary Conditions.

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ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding or proposal requirements.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Architect's duties.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 Architect/Initial Decision Maker

The Architect/Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2. The Architect/Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretations or decisions rendered in good faith.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

§ 1.2.1.1 The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.In the event of conflicts or discrepancies among the Contract Documents, interpretations will be based on the following priorities:

1. The Agreement
2. Change Orders and Supplemental Instructions.
3. Addenda, with those of later date having precedence over those of earlier date.
4. The Supplementary Conditions.
5. The General Conditions of the Contract for Construction.
6. Drawings and Specifications. In the case of an inconsistency between Drawings and Specifications or within either Document not clarified by addendum, the better quality or great quantity of Work shall be provided in accordance with the Architect's interpretations.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ 1.5.1 The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and retain all common law, statutory, and other reserved rights in their Instruments of Service, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, material, equipment suppliers, and suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors, material, equipment supppliers, and suppliers are authorized to use and reproduce the Instruments of Service provided to them, subject to any protocols established pursuant to Sections 1.7 and 1.8, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.6 Notice

§ 1.6.1 Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement.

§ 1.6.2 Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to the designated representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery.

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon written protocols governing the transmission and use of, and reliance on, Instruments of Service or any other information or documentation in digital form.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to written protocols governing the use of, and reliance on, the information contained in the model shall be at the using or relying party's sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 The Owner shall furnish to the Contractor, within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of, or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.

§ 2.2 Evidence of the Owner's Financial Arrangements

§ 2.2.1 Prior to commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. The Contractor shall have no obligation to commence the Work until the Owner provides such evidence. If commencement of the Work is delayed under this Section 2.2.1, the Contract Time shall be extended appropriately.

§ 2.2.2 Following commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract only if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due; or (3) a change in the Work materially changes the Contract Sum. If the Owner fails to provide such evidence, as required, within fourteen days of the Contractor's request, the Contractor may immediately stop the Work and, in that event, shall notify the Owner that the Work has stopped. However, if the request is made because a change in the Work materially changes the Contract Sum under (3) above, the Contractor may immediately stop only that portion of the Work affected by the change until reasonable evidence is provided. If the Work is stopped under this Section 2.2.2, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided in the Contract Documents.

§ 2.2.3 After the Owner furnishes evidence of financial arrangements under this Section 2.2, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.4 Where the Owner has designated information furnished under this Section 2.2 as "confidential," the Contractor shall keep the information confidential and shall not disclose it to any other person. However, the Contractor may disclose "confidential" information, after seven (7) days' notice to the Owner, where disclosure is required by law, including a subpoena or other form of compulsory legal process issued by a court or governmental entity, or by court or arbitrator(s) order. The Contractor may also disclose "confidential" information to its employees, consultants, sureties, Subcontractors and their employees, Sub-subcontractors, and others who need to know the content of such information solely and exclusively for the Project and who agree to maintain the confidentiality of such information.

§ 2.3 Information and Services Required of the Owner

§ 2.3.1 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.3.2 The Owner shall retain an architect lawfully licensed to practice architecture, or an entity lawfully practicing architecture, in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

§ 2.3.3 If the employment of the Architect terminates, the Owner shall employ a successor to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ 2.3.4 The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Workwith the exception of utilities to be field verified by the Contractor. The Contractor shall be responsible to have public and private utilities located within the areas being disturbed to implement the work on site..

§ 2.3.5 The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.3.6 Unless otherwise provided in the Contract Documents, the Contractor will be furnished free of charge, such copies of the Contract Documentsas are reasonably necessary for execution of the Work. Following the initial issue of Drawings and Project Manuals, additional copies requested by the Contractor will be furnished at the cost of reproduction, postage and handling.

§ 2.4 Owner's Right to Stop the Work

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

§ 2.5 Owner's Right to Carry Out the Work

§ 2.5.1 Prior to the substantial completion, if the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and the Architect may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15.

§ 2.5.2 After substantial completion, if the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails to correct such deficiencies within 3 days of receipt of written notice from the Architect or Owner, the Owner may, without prejudice to other remedies the Owner may have, correct such deficiencies. In such case an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the reasonable cost of correcting such deficiencies, including Owner's expenses and

compensation for the Architect's additional services made necessary by such default, neglect or failure. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.3.4, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ 3.2.3 The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by or made known to the Contractor as a request for information in such form as the Architect may require.

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the Owner, subject to Section 15.1.7, as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities unless the Contractor recognized such error, inconsistency, omission or difference and knowingly failed to report it to the Architect.

§ 3.3 Supervision and Construction Procedures

§ 3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work under the Contract. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences, or procedures, the Contractor shall evaluate the jobsite safety thereof and shall be solely responsible for the jobsite safety of such means, methods, techniques, sequences, or procedures. If the Contractor determines that such means,

methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely notice to the Owner and Architect, and shall propose alternative means, methods, techniques, sequences, or procedures. The Architect shall evaluate the proposed alternative solely for conformance with the design intent for the completed construction. Unless the Architect objects to the Contractor's proposed alternative, the Contractor shall perform the Work using its alternative means, methods, techniques, sequences, or procedures.

§ 3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.4 Labor and Materials

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

§ 3.4.2 Except in the case of minor changes in the Work approved by the Architect in accordance with Section 3.12.8 or ordered by the Architect in accordance with Section 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.After the Contract has been executed, the Owner and Architect will consider a formal request for the substitution of products in place of those specified only under the conditions set forth in Section 01 25 00 – Substitution Procedures.

§ 3.4.3 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

§ 3.5 Warranty

§ 3.5.1 The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.5.2 All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.6 Taxes

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

The Owner will pay for plan review fees; the Contractor is responsible to pay for the building permit and surcharge fee to the local jurisdiction.

§ 3.7.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ 3.7.3 If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than 14 days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may submit a Claim as provided in Article 15.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

§ 3.8 Allowances

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

- **.1** allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- **.2** Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and
- **.3** whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.Important communications shall be confirmed in writing. Other communications shall be similarly confirmed on written request in each case.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Architect may notify the Contractor, stating whether the Owner or the Architect (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall submit for the Owner's and Architect's information a Contractor's construction schedule for the Workas required by Section 01 32 16 Construction Progress Scheduling. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits current under the Contract Documents. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project.

§ 3.10.2 The Contractor, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal scheduleas required by Section 01 32 16 Construction Progress Scheduling, shall submit a submittal schedule for the Architect's approval. The Architect's approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

§ 3.11 Documents and Samples at the Site

The Contractor shall maintain at the site for the Owner one copy of the Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and one copy of Architect reviewed Shop Drawings, Product Data, Samples and similar required submittals. These shall be available to the Architect and shall be delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ 3.12 Shop Drawings, Product Data and Samples

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

§ 3.12.3 Samples are physical examples that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.Shop drawings submitted prior to issuance of the building permit are at the Contractors risk.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Architect, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.Submittals which are not marked as reviewed for compliance with the Contract Documents and approved by the Contractor may be returned by the Architect without action.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been reviewed by the Architect.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Architect's review of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified the Architect of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Architect's review thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such notice, the Architect's review of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ 3.12.10.1 If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings, and other submittals related to the Work, designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ 3.12.10.2 If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Architect at the time and in the form specified by the Architect.

§ 3.13 Use of Site

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.The Contractor shall accept the site as it exists. The care, custody and

control of the project site shall be vested in the Contractor, subject to the rights of the Owner.

§ 3.14 Cutting and Patching

§ 3.14.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting, or patching shall be restored to the condition existing prior to the cutting, fitting, or patching, unless otherwise required by the Contract Documents.

§ 3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter construction by the Owner or a Separate Contractor except with written consent of the Owner and of the Separate Contractor. Consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold, from the Owner or a Separate Contractor, its consent to cutting or otherwise altering the Work.

§ 3.15 Cleaning Up

§ 3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

§ 3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

§ 3.16 Access to Work

The Contractor shall provide the Owner and Architect with access to the Work in preparation and progress wherever located.

§ 3.17 Royalties, Patents and Copyrights

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect.

§ 3.18 Indemnification

§ 3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation, or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts, or other employee benefit acts.

§ 3.19 PROJECT MANAGER

§ 3.19.1 The Contractor shall employ a competent project manager who shall be present and run all construction progress meetings. The project manager shall be responsible for providing accurate and up-to-date construction and submittal schedules at each construction progress meeting.

§ 3.19.2 When requested by the Owner or Architect, the project manager shall:

a. Assist in resolving scope conflicts between sub-contractors in a timely fashion to ensure project progress matches published construction schedule.
b. Have sub-contractors attend construction progress meetings.
c. Manage the resolution of issues that arise during the punchlist/closeout/warranty period when the job superintendent is no longer on site.

§ 3.19.3 The Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner through the Architect the name and qualifications of a proposed project manager. The Architect may reply within 14 days to the Contractor is writing stating (1) whether the Owner or the Architect has reasonable objection to the proposed project manager or (2) that the Architect required additional time to review. Failure of the Architect to reply within the 14 day period shall constitute notice of no reasonable objection.

§ 3.19.4 The Contractor shall not employ a proposed project manager to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the project manager without the Owner's consent, which shall not unreasonably be withheld or delayed.

ARTICLE 4 ARCHITECT

§ 4.1 General

§ 4.1.1 The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement.The term "Architect" means the Architect or the Architect's authorized representative.

§ 4.1.2 Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the Owner, Contractor, and Architect. Consent shall not be unreasonably withheld.

§ 4.1.3 If the employment of the Architect is terminated, the Owner shall employ a successor architect as to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ 4.2 Administration of the Contract

§ 4.2.1 The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the end of the warranty period which ends one year from the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ 4.2.2 The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and promptly report to the Owner (1) known deviations from the Contract Documents, (2) known deviations from the most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.2.4 Communications

The Owner and Contractor shall include the Architect in all communications that relate to or affect the Architect's services or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise relating to the Project. Communications by

and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

§ 4.2.5 Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ 4.2.6 The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.4.2 and 13.4.3, whether or not the Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ 4.2.7 The Architect will review and take one of the following actions: Reviewed; Rejected; Review Comments; Revise and Resubmit upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, the Architectwill determine timelines. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities,coordinating the Work, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

§ 4.2.8 The Architect will prepare Change Orders and Construction Change Directives, and may order minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ 4.2.10 If the Owner and Architect agree, the Architect will provide one or more Project representatives to assist in carrying out the Architect's responsibilities at the site. The duties, responsibilities and limitations of authority of such project representatives shall be as set forth in an exhibit to be incorporated in the Contract Documents.

§ 4.2.11 The Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ 4.2.12 Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either, and will not be liable for results of interpretations or decisions rendered in good faith.

§ 4.2.13 The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ 4.2.14 The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ 5.2 Award of Subcontracts and Other Contracts for Portions of the Work

§ 5.2.1 Unless otherwise stated in the Contract Documents, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design. Within 20 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. Failure of the Owner or Architect to provide notice within the 20-day period shall constitute notice of no reasonable objection.

§ 5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.3 If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution.

§ 5.2.5 The Contractor, prior to contract award, shall submit electronically to the architect a notarized copy of MN Responsible Contractor Compliance Affidavit from each sub-contractor. If a sub-contractor is substituted during the project, a new MN Responsible Contractor Compliance Affidavit will be required.

§ 5.3 Subcontractual Relations

By appropriate written agreement, written where legally required for validity, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

§ 5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided

that

.1 assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor; and

.2 assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 Owner's Right to Perform Construction and to Award Separate Contracts

§ 6.1.1 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.If the Contractor claims that delay or additional cost is involved because of such action by the Owner, the Contractor shall make such Claim as provided in Article 15.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each Separate Contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ 6.1.4 Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces or with Separate Contractors, the Owner or its Separate Contractors shall have the same obligations and rights that the Contractor has under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6, and Articles 10, 11, and 12.

§ 6.2 Mutual Responsibility

§ 6.2.1 The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ 6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly notify the Architect of apparent discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Architect of apparent discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not apparent.

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate Contractor's delays, improperly timed activities, damage to the Work or defective construction.

§ 6.2.4 The Contractor shall promptly remedy damage that the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

§ 6.2.5 The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.3 Owner's Right to Clean Up

If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Architect will allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

§ 7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ 7.1.2 A Change Order shall be based upon agreement among the Owner, Contractor, and Architect. A Construction Change Directive requires agreement by the Owner and Architect and may or may not be agreed to by the Contractor. An order for a minor change in the Work may be issued by the Architect alone.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly with changes in the Work, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work.

§ 7.2 Change Orders

§ 7.2.1 A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

- **.1** The change in the Work;
- **.2** The amount of the adjustment, if any, in the Contract Sum; and
- **.3** The extent of the adjustment, if any, in the Contract Time.

§ 7.3 Construction Change Directives

§ 7.3.1 A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ 7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ 7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- **.1** Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- **.2** Unit prices stated in the Contract Documents or subsequently agreed upon;
- **.3** Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- **.4** As provided in Section 7.3.4.

§ 7.3.4 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.4 shall be limited to the following:

.1 Costs of laborand overhead as provided in Section 7.5;

.2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;

.3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;and

.4 Costs of premiums for all permit fees, and sales, use, or similar taxes, directly related to the Work.

§ 7.3.5 If the Contractor disagrees with the adjustment in the Contract Time, the Contractor may make a Claim in accordance with applicable provisions of Article 15.

§ 7.3.6 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Architect of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

§ 7.3.7 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.3.8 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

§ 7.3.10 When the Owner and Contractor agree with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ 7.4 Minor Changes in the Work

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will affect the Contract Sum or Contract Time, the Contractor shall notify the Architect and shall not proceed to implement the change in the Work. If the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

§ 7.5 CHANGES IN CONTRACT SUM

§ 7.5.1 For any adjustments to the Contract Sum based on other than the unit prices method, the Contractor agrees to charge and accept payment for his overhead, bond, insurance, office project management and supervision estimating

time/costs, field management and supervision including the field superintendent, foreman and all other management staff onsite, as-built modification, use or replacement of tools, shop burden, equipment rental (other than specifically required additional hoisting equipment, required excavating equipment or similar equipment necessary solely as a result of the change), engineering costs, cost of safety measures (including those imposed by OSHA), parking charges, general jobsite clean-up, testing, permits (unless a new permit is required) or any other costs not associated with the change at the following percentages of the cost attributable to the change in the Work:

1. Ten percent (10%) for Work (labor, labor insurance and materials by the Contractor not involving subcontractors;
2. Five percent (5%) for Work (labor, labor insurance and materials) by subcontractors;
3. When both additions and credits are involved in any one proposal request, the allowance for overhead, bond, insurance, office project management, estimating time, field supervision, as-built modification and profit shall be figured on the basis of the net increase, if any;
4. For additional Work ordered as described above which will be executed by Subcontractors of the Contractor, it is agreed Subcontractors will be permitted to charge ten percent (10%) for work not involving sub-subcontractors and five percent (5%) for Work by sub-subcontractors to the net subcontract amount the Contractor may add five percent (5%).

§ 7.5.2 A breakdown of material and an hourly breakdown of labor must be submitted with each request for additional compensation.

ARTICLE 8 TIME

§ 8.1 Definitions

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ 8.1.2 The date of commencement of the Work is the date established in the Agreement.

§ 8.1.3 The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ 8.2.2 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, commence the Work prior to the effective date of insurance required by Article 11 to be furnished by the Contractor and Owner.The date of commencement of the Work shall not be changed by the effective date of such insurance.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate Contractoremployed by the Owner; (2) by changes ordered in the Work; (3) by labor disputes, fire, unusual delay in deliveries, unavoidable casualties, encountering Hazardous Materials, transportation delays not reasonably foreseeable, general labor disputes impacting the Project, but not specifically related to the Worksite, Terrorism, epidemics, adverse governmental actions, adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor's control; (4) by delay authorized by the Owner pending arbitration or litigation as provided for herein; or (5) by other causes that the Architect determines, justify delay, then the Contract Time shall be extended for such reasonable time as the Architect may determine.

§ 8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Article 15.NOTICE OF DELAYS: If delays to the Work are encountered for any reason, the Contractor shall provide prompt written notice

to the Architect of the cause of such delays after the Contractor first recognizes and can substantiate the delay. The Parties each agree to take reasonable steps to mitigate the effect of such delays.

§ 8.3.3 This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ 9.1.1 The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.1.2 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit four (4) copies of the schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Architect may require, and unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.2.2 Projects with multiple sites or multiple phased projects, provide separate schedule of values for each building, phase or site.

§ 9.2.3 The schedule of values shall include the following line items with values calculated as follows:

Operations and maintenance manuals	.125% of contract value
As-built drawings	.0625% of contract value
Training	.125% of contract value
Attic stock materials	.0625% of contract value
Mechanical/Electrical Coordination Drawings	.0625% of contract value

§ 9.2.4 The schedule of values shall be broken down with separate line items for labor and materials corresponding to each specification section.

§ 9.3 Applications for Payment

§ 9.3.1 At least ten days before the date established for each progress payment, the Contractor shall submitfour (4) copies to the Architect an itemized Application for Payment(AIA Document G702 and G703) prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work. The application shall be notarized, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ 9.3.1.1 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

§ 9.3.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or material supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ 9.3.1.3 Until Substantial Completion, the Owner shall make progress payments in the amount of ninety-five percent (95%) of the amount due the Contractor.

§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, and transportation to the site, for such materials and equipment stored off the site.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.4 Certificates for Payment

§ 9.4.1 The Architect will, within seven days after receipt of the Contractor's Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or (3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Architect. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.5 Decisions to Withhold Certification

§ 9.5.1 The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

- **.1** defective Work not remedied;
- **.2** third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;
- **.3** failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;
- **.4** reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- **.5** damage to the Owner or a Separate Contractor;
- **.6** reasonable evidence that the Work will not be completed within the Contract Time, and that the

unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or

.7 repeated failure to carry out the Work in accordance with the Contract Documents.

.8 schedules are not updated in accordance with the Contract Documents.

.9 MN Responsible Contractor Compliance Affidavits have not been submitted.

§ 9.5.2 When either party disputes the Architect's decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, that party may submit a Claim in accordance with Article 15.

§ 9.5.3 When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.4 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Contractor shall reflect such payment on its next Application for Payment.

§ 9.6 Progress Payments

§ 9.6.1 After the Architect has issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

§ 9.6.2 The Contractor shall pay each Subcontractor, no later than ten days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work.Per 471.425 Minnesota Statutes, the prime contractor must pay any subcontractor within ten days of the prime contractor's receipt of payment from the Public Body/Owner for undisputed services provided by the subcontractor. The prime contractor must pay the subcontractor interest of 1 ½ percent per month on any disputed amounts not paid on time. The minimum monthly interest penalty payment for an unpaid balance of $100 or more is $10. For an unpaid balance of less than $100, the prime contractor shall pay the actual penalty due to the subcontractor. A subcontractor who prevails in a civil action to collect interest penalties from a prime contractor must be awarded its costs and disbursements, including attorney's fees, incurred in bringing the action. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law.

§ 9.6.5 The Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors or provided by suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, create any fiduciary liability or tort liability on the part of the Contractor for breach of trust, or entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ 9.6.8 Provided the Owner has fulfilled its payment obligations under the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

§ 9.7 Failure of Payment

If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents, the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven additional days' written notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided for in the Contract Documents.

§ 9.8 Substantial Completion

§ 9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.If the Work is to be followed by construction by the Owner or by the separate contractors, Substantial Completion shall be defined as the readiness of the Work for the commencement of such construction.

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§ 9.8.3 Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance; and fix the time which the Contractor shall complete all items on the list accompanying the Certificate to sixty (60) calendar days. The Contractor will submit a punchlist completion schedule within ten (10) days of receipt of Certificate of Substantial Completion. Any cost incurred by the Architect or Architect's consultants (after 60 calendar days of substantial completion) to close out the project will be deducted from the Contractor's contract by change order. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion. Warranties on punchlist items will commence on the date of final payment.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.The payment shall be sufficient to increase the total payments to one hundred percent (100%) of the Contract Sum, less such amounts as the Owner and Architect shall determine for incomplete work and unsettled claims. The Owner has no obligation to make incremental retainage reductions after the initial determination for the incomplete work and unsettled claims.

§ 9.9 Partial Occupancy or Use

§ 9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer as required under section 11.3.1.5 and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

§ 9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor, and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ 9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

§ 9.10 Final Completion and Final Payment

§ 9.10.1 Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection. When the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance withthe terms and conditions of the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effectand will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to the Owner, (3) a written statement that the Contractor knows of no substantial reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5) if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien. If such lien remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging the lien including all costs and reasonable attorneys' fees.

§ 9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

§ 9.10.4 The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

.1 liens, Claims, security interests, or encumbrances arising out of the Contract and unsettled;

.2 failure of the Work to comply with the requirements of the Contract Documents;

.3 terms of special warranties required by the Contract Documents; or

.4 audits performed by the Owner, if permitted by the Contract Documents, after final payment.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

§ 9.10.6 Before final payment is made, a certification of satisfaction, Minnesota Tax Form 134, from the State Commissioner of Taxation must be furnished by the Contractor and all Subcontractors in accordance with Minnesota State Law (re: certification of satisfaction of state withholding taxes paid).

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.2 Safety of Persons and Property

§ 10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to

.1 employees on the Work and other persons who may be affected thereby;

.2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and

.3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

§ 10.2.2 The Contractor shall comply with, and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, bearing on safety of persons or property or their protection from damage, injury, or loss.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel.

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3. The Contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ 10.2.8 Injury or Damage to Person or Property

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

§ 10.3 Hazardous Materials and Substances

§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials or substances. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Architect of the condition.

§ 10.3.2 Upon receipt of the Contractor's written notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up.

§ 10.3.3 To the fullest extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss, or expense is due to the fault or negligence of the party seeking indemnity.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for hazardous materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

§ 10.3.5 The Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

§ 10.3.6 If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall reimburse the Contractor for all cost and expense thereby incurred.

§ 10.4 Emergencies

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 Contractor's Insurance and Bonds

§ 11.1.1 The Contractor shall purchase from and maintain in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located such insurance as will protect the Contractor from claims set forth below which may arise out of or result from the Contractor's operations and completed operations under the Contract and for which the Contractor may be legally liable, whether such operations be by the Contractor or by a Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

.1 Claims under workers' compensation, disability benefit and other similar employee benefit acts that are applicable to the Work to be performed;

.2 Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;

.3 Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;

.4 Claims for damages insured by usual personal injury liability coverage; which are sustained (1) by a person as a result of an offense directly or indirectly related to employment of such person by the Contractor, or (2) by another person;

.5 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;

.6 Claims for damages because of bodily injury, death of a person or property damage arising out of ownership, maintenance or use of a motor vehicle;

.7 Claims for bodily injury or property damage arising out of completed operations; and

.8 Claims involving contractual liability insurance applicable to the Contractor's obligations under Section 3.18.

.9 Liability insurance shall include all major divisions of coverage and be on a comprehensive basis including:

a. Premises Operations (including X, C, and U coverages as applicable).

b. Independent Contractors' Protective.

c. Products and Completed Operations.

d. Personal Injury Liability with Employment Exclusion deleted, or Employment Practices Liability.

e. Contractual – including specified provision for Contractor's obligations under Paragraph 3.18.

f. Owned, non-owned and hired motor vehicles.

g. Broad Form Property Damage including Completion Operations.

h. Umbrella Excess Liability.

.10 A General Liability or Umbrella Liability Policy on a claims-made basis will not be accepted.

§ 11.1.2 The insurance required by Section 11.1.1 shall be written for not less than limits of liability specified in the Contract Documents or required by law, whichever coverage is greater. Coverages, whether written on an occurrence or claims-made basis, shall be maintained without interruption from the date of commencement of the Work until the date of final payment and termination of any coverage required to be maintained after final payment, and, with respect to the Contractor's completed operations coverage, until the expiration of the period for correction of Work or for such other period for maintenance of completed operations coverage as specified in the Contract Documents.

a. Workers' Compensation:

1) Minnesota Statutory

2) Employer's Liability: $100,000 per accident
$500,000 disease, policy limit
$100,000 disease, each employee

b.	Comprehensive or Commercial General Liability (including Premises-Operations; Independent Contractor's Protective; Products and Completed Operations; Broad Form Property Damage):	
	1) Bodily Injury:	$500,000 each occurrence $1,000,000 aggregate
	2) Property Damage:	$500,000 each occurrence $1,000,000 aggregate
	3) Products and Completed Operations to be maintained for 2 years after final payment:	$1,000,000 aggregate
	4) Property Damage Liability Insurance shall provide X, C and U coverage.	
	5) Broad Form Property Damage Coverage shall include Completed Operations.	
c.	Contractual Liability	
	1) Bodily Injury	$500,000 each occurrence $1,000,000 aggregate
	2) Property Damage:	$500,000 each occurrence $1,000,000 aggregate
d.	Personal Injury, with Employment Exclusion deleted:	$1,000,000 aggregate
	Employment Practices Liability	$1,000,000 aggregate
e.	Business Auto Liability (including owned, non-owned and hired vehicles):	
	1) Bodily Injury:	$1,000,000 each person $1,000,000 each occurrence
	2) Property Damage:	$1,000,000 each occurrence
f.	If the General Liability coverages are provided by a Commercial Liability policy, the:	
	1) General Aggregate shall be not less than $2,000,000 and it shall apply, in total, to this Project only.	
	2) Fire Damage Limit shall be not less than $100,000 on any one fire.	
	3) Medical Expense Limit shall be not less than $5,000 on any one person.	
g.	Umbrella Excess Liability:	$3,000,000 over primary insurance. $10,000 retention for self-insured hazards, each occurrence.

§ 11.1.3 Certificates of insurance acceptable to the Owner shall be filed with the Owner prior to commencement of the Work and thereafter upon renewal or replacement of each required policy of insurance. These certificates and the insurance policies required by this Section 11.1 shall contain a provision that coverages afforded under the policies will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to the Owner. An additional certificate evidencing continuation of liability coverage, including coverage for completed operations, shall be submitted with the final Application for Payment as required by Section 9.10.2 and thereafter upon renewal or replacement of such coverage until the expiration of the time required by Section 11.1.2. Information concerning reduction of coverage on account of revised limits or claims paid under the General Aggregate, or both, shall be furnished by the Contractor with reasonable promptness. If this insurance is written on the Comprehensive General Liability policy form, the Certificates shall be AIA Document G705, Certificate of Insurance. If this insurance is written on a Commercial General Liability policy form, ACORD form 25S will be acceptable. In addition to the required certificates, copies of policy endorsements indicating the Owner as Additional Insured shall be provided to the Owner.

§ 11.1.4 The Contractor shall cause the commercial liability coverage required by the Contract Documents to include (1) the Owner, the Architect and the Architect's Consultants as additional insureds for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's operations; and (2) the Owner as an additional insured for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's completed operations. The policy limits shall be not less than $1,500,000.

§ 11.1.5 The insurance required by subparagraph 11.1.1 shall include an Indemnification clause as respect to General Liability and Worker's Compensation coverages.

§ 11.1.6 The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 11.1.7 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

§ 11.1.8 Notice of Cancellation or Expiration of Contractor's Required Insurance. Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ 11.2 PROPERTY INSURANCE

§ 11.2.1 The Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located, property insurance (Special Form) in the amount of the initial Contract Sum as well as subsequent modifications thereto for the entire work at the site on a replacement cost basis. The Contractor shall be responsible for payment of all deductibles resulting from losses under the coverage provided herein. Such insurance will cover damage to work completed, materials installed and awaiting installation, and all materials in transit for the Project. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until all phases are substantially complete or until no person or entity other than the Owner has an insurable interest in the property required by this Paragraph 11.4 to be covered, whichever is earlier. This insurance shall include interests of the Owner, Architects, Engineers, Architect's consultants, Contractor, Subcontractors and Sub-subcontractors in the Work. The form of policy for this coverage shall be completed Value. If the Owner is damaged by the failure of the Contractor to maintain such insurance, then the contractor shall bear all reasonable costs properly attributable thereto.

§ 11.2.1.1 Property insurance shall be on an "all-risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss or damage including, without duplication of coverage, theft, vandalism, malicious mischief, collapse, earthquake, flood, windstorm, falsework, testing and startup, temporary buildings and debris removal including demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for Architect's and Contractor's services and expenses required as a result of such insured loss.

§ 11.2.1.4 This property insurance shall cover portions of the Work stored off the site, and also portions of the Work in transit.

§ 11.2.1.5 Partial occupancy or use in accordance with Section 9.9 shall not commence until the insurance company or companies providing property insurance have consented to such partial occupancy or use by endorsement or otherwise. The Owner and the Contractor shall take reasonable steps to obtain consent of the insurance company or companies and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

§ 11.2.2 BOILER AND MACHINERY INSURANCE

The Owner shall purchase and maintain boiler and machinery insurance required by the Contract Documents or by law, which shall specifically cover such insured objects during installation and until final acceptance by the Owner; this insurance shall include interests of the Owner, Contractor, Subcontractors and Sub-subcontractors in the Work, and the Owner and Contractor shall be named insureds. The testing exclusion shall be removed from this policy.

§ 11.2.3 LOSS OF USE INSURANCE
The Owner, at the Owner's option, may purchase and maintain such insurance as will insure the Owner against loss of use of the Owner's property due to fire or other hazards, however caused. The Owner waives all rights of action against the Contractor for loss of use of the Owner's property, including consequential losses due to fire or other hazards however caused.

§ 11.2.5 If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, the Owner shall waive all rights in accordance with the terms of Section 11.3.7 for damages caused by fire or other causes of loss covered by this separate property insurance. All separate policies shall provide this waiver of subrogation by endorsement or otherwise.

§ 11.2.6 Before an exposure to loss may occur, the Contractor shall file with the Owner through the Architect, two certified copies of the policy or policies providing this Property Insurance Coverage, each containing those endorsements specifically related to the Project.

§ 11.2.7 Owner's Insurance
§ 11.2.7.1 The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Owner shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located.

§ 11.3 Waivers of Subrogation
§ 11.3.1 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents and employees, each of the other, and (2) the Architect, Architect's consultants, separate contractors described in Article 6, if any, and any of their subcontractors, sub-subcontractors, agents and employees, for damages caused by fire or other causes of loss to the extent covered by property insurance obtained pursuant to this Section 11.3 or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance held by the Contractor as fiduciary. The Owner or Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors described in Article 6, if any, and the subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

§ 11.3.2 A loss insured under this property insurance shall be adjusted by the Contractor as fiduciary and made payable to the Contractor as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.3.10. The Contractor shall pay Subcontractors their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors to make payments to their Sub-subcontractors in similar manner.

§ 11.3.3 If required in writing by a party in interest, the Contractor as fiduciary shall, upon occurrence of an insured loss, give bond for proper performance of the Contractor's duties. The cost of required bonds shall be charged against proceeds received as fiduciary. The Contractor shall deposit in a separate account proceeds so received, which the Contractor shall distribute in accordance with such agreement as the parties in interest may reach, or as

determined in accordance with the method of binding dispute resolution selected in the Agreement between the Owner and Contractor. If after such loss no other special agreement is made and unless the Owner terminates the Contract for convenience, replacement of damaged property shall be performed by the Contractor after notification of a Change in the Work in accordance with Article 7.

§ 11.3.4 The Contractor as fiduciary shall have power to adjust and settle a loss with insurers unless one of the parties in interest shall object in writing within five days after occurrence of loss to the Contractor's exercise of this power; if such objection is made, arbitrators shall be chosen as provided in Paragraph 15.4. The Contractor as fiduciary shall in that case make settlement with insurers or, in accordance with the directions of the arbitrators.

§ 11.3.5 In the event of partial occupancy or use in accordance with Paragraph 9.9, the Contractor shall notify the insurance company and obtain a "Use and Occupancy Waiver" such that the policy will not be invalidated by occupancy.

§ 11.3.6 All insurance policies shall contain a provision stating that coverages afforded under any of the aforesaid insurance policies shall not be cancelled or materially changed without at least thirty (30) days prior written notice to the Owner. On all Certificate forms, the words "endeavor to" and the remaining words beginning with "but failure to" shall be stricken from the cancellation notice provision.

§ 11.3.7 All insurance policies shall be underwritten with responsible insurance carriers with Best's Rating of not less than A and X and otherwise satisfactory to the Owner and licensed to provide insurance in the state in which the project is located. Non-admitted carriers may be considered on an individual basis.

§ 11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance

The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss. The Owner waives all rights of action against the Contractor and Architect for loss of use of the Owner's property, due to fire or other hazards however caused.

§ 11.5.1 The Contractor shall furnish bond or bonds as described below, covering the faithful performance of the Contract and the payments of all obligations arising thereunder. The Contract will not be signed until the Owner has received the proper bond specified under this Article, issued by a bonding company licensed to do business in the State where the construction will take place, and on the current list of Company's Holding Certificates of Authority as acceptable Sureties on Federal Bonds and as acceptable reinsuring companies as published in Circular 570 (Amended) by the Audit Staff Bureau of Accounts, U.S. Treasury Department. All bonds signed by an agent must be accompanied by a certified copy of the authority to act.

§ 11.5.1.1 Furnish both AIA A312 Performance Bond and AIA A312 Payment Bond in the amount of 100% of the Contract Price.

§ 11.5.1.2 The Performance Bond and Payment Bond shall be submitted in the exact form specified in Section 11.4.1.1, above, and with the certificates specified in Section 11.4.1.3, below, and no other modifications or addendum whatsoever shall be allowed.

§ 11.5.1.3 Duly executed, notarized and updated Acknowledgments of both the Principal and Surety and the Surety's Power of Attorney must be attached to each of the two required bonds.

§ 11.5.1.4 Bond amounts shall not exceed the single bond limit for the Contractor's bonding company as set forth in the Federal Register current as of the bid date.

§ 11.5.2 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

§ 12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically

expressed in the Contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the Contractor's expense without change in the Contract Time.

§ 12.1.2 If a portion of the Work has been covered that the Architect has not specifically requested to examine prior to its being covered, the Architect may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement shall, by appropriate Change Order, be at the Owner's expense. If such Work is not in accordance with the Contract Documents, such costs and the cost of correction, shall be at the Contractor's expenseunless the condition was caused by the Owner or a separate contractor in which event the Owner shall be responsible for payment of such costs.

§ 12.2 Correction of Work

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt ofwritten notice from the Owneror Architect to do so, unless the Owneror Architect has previously given the Contractor a written acceptance of such condition. The Owneror Architect shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner or Architect fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.5.

§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of incomplete or defective Work noted on the Certificate of Substantial Completion shall commence at final payment.

§ 12.2.2.3 The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.3 Acceptance of Nonconforming Work

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the law of the place where the Project is located except that, if the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.

§ 13.2 Successors and Assigns

§ 13.2.1 The Owner and Contractor respectively bind themselves, their partners, successors, assigns, and legal representatives to covenants, agreements, and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate the assignment.

§ 13.2.3 Written notice shall be deemed to have been duly served if delivered in person to the individual, to a member of the firm or entity, or to an officer of the corporation for which it was intended; or if delivered at, or sent by registered or certified mail or by courier service providing proof of delivery to, the last business address known to the party giving notice.

§ 13.3 Rights and Remedies

§ 13.3.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ 13.3.2 No action or failure to act by the Owner, Architect, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ 13.4 Tests and Inspections

§ 13.4.1 Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Architect timely notice of when and where tests and inspections are to be made so that the Architect may be present for such procedures. The Owner shall bear costs of (1) tests, inspections, or approvals that do not become requirements until after bids are received or negotiations concluded, and (2) tests inspections, or approvals where building codes or applicable laws or regulations prohibit the Owner from delegating their cost to the Contractor.

§ 13.4.2 If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Owner's expense.

§ 13.4.3 If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Architect's services and expenses, shall be at the Contractor's expense.

§ 13.4.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

§ 13.4.5 If the Architect is to observe tests, inspections, or approvals required by the Contract Documents, the

Architect will do so promptly and, where practicable, at the normal place of testing.

§ 13.4.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at the rate the parties agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

§ 13.7 EQUAL OPPORTUNITY

§ 13.7.1 The Contractor shall maintain policies of employment as follows:

§ 13.7.1.1 The Contractor and the Contractor's Subcontractors shall not discriminate against any employee or applicant for employment because of race, religion, color, sex or national origin. The Contractor shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, religion, color, sex or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the policies of non-discrimination.

§ 13.7.1.2 The Contractor and the Contractor's Subcontractors shall, in all solicitations or advertisements for employees placed by them or on their behalf, state that all qualified applicants will receive consideration for employment without regard to race, religion, color, sex or national origin.

§ 13.8 NON-MINNESOTA CONTRACTOR. Non-Minnesota Contractors for contracts that exceed or can reasonably be expected to exceed $100,000 shall comply with the following Minnesota Department of Revenue Requirements (MN Law, MS 290.9705):

File form SDE (Exemption from Surety Deposits for Non-Minnesota Contractors) with the Minnesota Revenue, Mail Station 6501, St. Paul, Minnesota 55146-6501. An exemption will be granted if:

.1 The Contractor provides a cash surety or bond (8% of total contract), secured by an Insurance Company licensed in Minnesota, which guarantees compliance with all provisions of Minnesota withholding, sales and corporate income tax laws, or:

.2 The Contractor provides evidence of full compliance with such laws on previous construction work in Minnesota during the last three years.

§ 13.8.2 Submit a copy of form SDE, certified by the Department of Revenue, with the Contractor's initial Application for Payment.

§ 13.8.3 If an exemption is not granted, 8 percent of each Application for Payment will be withheld as surety and deposited with the Department of Revenue, to be refunded with interest after the Contractor's State tax obligations are fulfilled.

§ 13.9 FIREARMS PROHIBITED

§ 13.9.1 No provider of services pursuant to this contract, including but not limited to employees, agents, suppliers or subcontractor's of the Contractor shall carry or possess a firearm on the Owner's premises or while acting on behalf of the Owner pursuant to the terms of this agreement. Violation of this provision shall be considered a substantial breach of the Agreement; and, in addition to any other remedy available to the Owner under law or equity. Violation of this provision is grounds for immediate suspension or termination of this contract.

§ 13.10 RESPONSIBLE CONTRACTOR REQUIREMENTS

§ 13.10.1 Pursuant to Minnesota Statutes 16C.285 "A Contractor must meet the minimum criteria in sub-division 3 to be eligible to be awarded a construction contract as the lowest bidder or the vendor or contractor offering the best value".

§ 13.10.2 The provision applies to publicly owned or financed projects where the contracting authority's construction contract with the prime contractor is estimated to exceed $50,000 and is awarded pursuant to a lowest responsible

bidder selection method or a best value selection method. A subcontractor must meet the minimum criteria in subdivision 3 to be eligible to be awarded a subcontract on a project regardless of the value of the subcontract.

§ 13.10.3 If only one prime contractor responds to a solicitation document, a contracting authority may award a construction contract to the responding prime contractor even if the minimum criteria in subdivision 3 are not met.

§ 13.10.4 Subd. 3 Minimum criteria "Responsible Contractor" means a contractor that conforms to the responsibility requirements in the solicitation document for its portion of the work on the project and verifies that it meets the following minimum criteria:

1. The Contractor:

   i. Is in compliance with workers' compensation and unemployment insurance requirements;

   ii. Is currently registered with the Department of Revenue and the Department of Employment and Economic Development if it has employees;

   iii. Has a valid federal tax identification number or a valid Social Security number if an individual; and

   iv. Has filed a certificate of authority to transact business in Minnesota with the secretary of state if a foreign corporation or cooperative;

2. The contractor or related entity is in compliance with and, during the three-year period before submitting the verification, has not violated section 177.24, 177.25, 177.41 to 177.44, 181.13, 181.14, or 181.722, and has not violated United States Code, title 29, sections 201 to 219, or United States Code, title 40, sections 3141 to 3148. For purposes of this clause, a violation occurs when a contractor or related entity:

   i. Repeatedly fails to pay statutorily required wages or penalties on one or more separate projects for a total underpayment of $25,000 or more within the three-year period;

   ii. Has been issued an order to comply by the commissioner of labor and industry that has become final;

   iii. Has been issued at least two determination letters within the three-year period by the Department of Transportation finding an underpayment by the contractor or related entity to its own employees;

   iv. Has been found by the commissioner of labor and industry to have repeatedly or willfully violated any of the sections referenced in this clause pursuant to section 177.27;

   v. Has been issued a ruling or findings of underpayment by the administrator of the Wage and Hour Division of the United States Department of Labor that have become final or have been upheld by an administrative law judge or the Administrative Review Board; or

   vi. Has been found liable for underpayment of wages or penalties or misrepresenting a construction worker as an independent contractor in an action brought in a court having jurisdiction.

   Provided that, if the contractor or related entity contests a determination of underpayment by the Department of Transportation in a contested case proceeding, a violation does not occur until the contested case proceeding has concluded with a determination that the contractor or related entity underpaid wages or penalties;

3. The contractor or related entity is in compliance with and, during the three-year period before submitting the verification, has not violated chapter 326B. For purposes of this clause, a violation occurs when a contractor or related entity has been issued a final administrative or licensing order;

4. The contractor or related entity has not, more than twice during the three-year period before submitting the verification, had a certificate of compliance under section 363A.36 revoked or suspended based on the provisions of section 363A.36, with the revocation or suspension becoming final because it was upheld by the Office of Administrative Hearings or was not appealed to the office;

5. The contractor or related entity has not received a final determination assessing a monetary sanction from the Department of Administration or Transportation for failure to meet targeted group business, disadvantaged business enterprise, or veteran-owned business goals, due to a lack of good faith effort, more than once during the three-year period before submitting the verification;

6. The contractor or related entity is not currently suspended or debarred by the federal government or the state of Minnesota or any of its departments, commissions, agencies, or political subdivisions; and

7. All subcontractors that the contractor intends to use to perform project work have verified to the contractor through a signed statement under oath by an owner or officer that they meet the minimum criteria listed in clauses 1 to 6.

Any violations, suspensions, revocations, or sanctions, as defined in clauses (2) to (5), occurring prior to July 1, 2014, shall not be considered in determining whether a contractor or related entity meets the minimum criteria.

§ 13.10.5 Subd. 4 Verification of compliance. A contractor responding to a solicitation document of a contracting authority shall submit to the contracting authority a signed statement under oath by an owner or officer verifying compliance with each of the minimum criteria in subdivision 3 at the time that it responds to the solicitation document. A contracting authority may accept a sworn statement as sufficient to demonstrate that a contractor is a responsible contractor and shall not be held liable for awarding a contract in reasonable reliance on that statement. Failure to verify compliance with any one of the minimum criteria or a false statement under oath in a verification of compliance shall render the prime contractor or subcontractor that makes the false statement ineligible to be awarded a construction contract on the project for which the verification was submitted. A false statement under oath verifying compliance with any of the minimum criteria may result in termination of a construction contract that has already been awarded to a prime contractor or subcontractor that submits a false statement. A contracting authority shall not be liable for declining to award a contract or terminating a contract based on a reasonable determination that the contractor failed to verify compliance with the minimum criteria or falsely stated that it meets the minimum criteria.

§ 13.10.6 Subd. 5 Subcontractor verification. A prime contractor or subcontractor shall include in its verification of compliance under subdivision 4 a list of all of its first-tier subcontractors that it intends to retain for work on the project. If a prime contractor or any subcontractor retains additional subcontractors on the project after submitting its verification of compliance, the prime contractor or subcontractor shall obtain verifications of compliance from each additional subcontractor with which it has a direct contractual relationship and shall submit a supplemental verification confirming compliance with subdivision 3, clause (7), within 14 days of retaining the additional subcontractors. A prime contractor shall submit to the contracting authority upon request copies of the signed verifications of compliance from all subcontractors of any tier pursuant to subdivision 3, clause (7). A prime contractor and subcontractors shall not be responsible for the false statements of any subcontractor with which they do not have a direct contractual relationship. A prime contractor and subcontractors shall be responsible for false statements by their first-tier subcontractors with which they have a direct contractual relationship only if they accept the verification of compliance with actual knowledge that it contains a false statement.

§ 13.10.7 Subd. 6 Additional criteria. Nothing in this section shall restrict the discretion of a contracting authority to establish additional criteria for defining a responsible contractor.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

.1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;

.2 An act of government, such as a declaration of national emergency, that requires all Work to be stopped;

.3 Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or

.4 The Owner has failed to furnish to the Contractor reasonable evidence as required by Section 2.2.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, repeated suspensions, delays or interruptions of the entire Work by the Owner as described in Section 14.3 constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, or their agents or employees or any other persons or entities performing portions of the Work because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may terminate the Contract if the Contractor

.1 repeatedly refuses or fails to supply enough properly skilled workers or proper materials;

.2 fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;

.3 repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or

.4 otherwise is guilty of substantial breach of a provision of the Contract Documents.

§ 14.2.2 When any of the above reasons exist, and upon certification by the Architect/Initial Decision Maker that sufficient cause exists to justify such action, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

.1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;

.2 Accept assignment of subcontracts pursuant to Section 5.4; and

.3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Architect/Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine.

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

.1 that performance is, was, or would have been, so suspended, delayed, or interrupted, by another cause for which the Contractor is responsible; or

.2 that an equitable adjustment is made or denied under another provision of the Contract.

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

.1 cease operations as directed by the Owner in the notice;

.2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and

.3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive payment for Work executed, and for proven out-of-pocket loss with respect to materials, equipment, tools, and construction equipment and machinery incurred by reason of such termination, but excluding any fee or profit on any unperformed Work.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim.

§ 15.1.2 Time Limits on Claims

Accrual dates for Statutes of Limitations are controlled by Minnesota Law.

§ 15.1.3 Notice of Claims

§ 15.1.3.1 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party and to the Architect/Initial Decision Maker with a copy.. Claims by either party under this Section 15.1.3.1 shall be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ 15.1.3.2 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents. The Architect will prepare Change Orders and issue Certificates for Payment in accordance with the decisions of the Architect/Initial Decision Maker.

§ 15.1.4.2 The Contract Sum and Contract Time shall be adjusted in accordance with the Architect/Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decision of the Architect/Initial Decision Maker.

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, notice as provided in Section 15.1.3 shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ 15.1.7 Waiver of Claims for Consequential Damages

The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

.1 damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and

.2 damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit, except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article 14. Nothing contained in this Section 15.1.7 shall be deemed to preclude assessment of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ 15.2 Initial Decision

§ 15.2.1 Claims, excluding those arising under Sections 10.3, 10.4, and 11.5, shall be referred to the Architect/Initial Decision Maker for initial decision. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to arbitration of any Claim. If an initial decision has not been rendered within 30 days after the Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and binding dispute resolution without a decision having been rendered. Unless the Architect/Initial Decision Maker and all affected parties agree, the Architect/Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Architect/Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Architect/Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Architect/Initial Decision Maker concludes that, in the Architect/Initial Decision Maker's sole discretion, it would be inappropriate for the Architect/Initial Decision Maker to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Architect/Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Architect/Initial Decision Maker in rendering a decision. The Architect/Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Architect/Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Architect/Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Architect/Initial Decision Maker that no supporting

data will be furnished. Upon receipt of the response or supporting data, if any, the Architect/Initial Decision Maker will either reject or approve the Claim in whole or in part.

§ 15.2.5 The Architect/Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Architect/Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to arbitration.

§ 15.2.6 Either party may file for arbitration of an initial decision at any time, subject to the terms of Section 15.2.6.1.

§ 15.2.6.1 When a written decision of the Architect/Initial Decision Maker states that (1) the decision is final but subject to arbitration, as provided for herein, and (2) a demand for arbitration of a Claim covered by such decision must be made within 30 days after the date on which the party making the demand receives the final written decision, then failure to demand arbitration within said 30 days' period shall result in the Architect's decision becoming final and binding upon the Owner and Contractor. If the Architect/Initial Decision Maker renders a decision after arbitration proceedings have been initiated, such decision may be entered as evidence, but shall not supersede arbitration proceedings unless the decision is acceptable to all parties concerned.

§ 15.2.7 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.8 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

§ 15.4 Arbitration

NOTE: All references to "Arbitration" in Section 15.4 shall be considered permissive and not mandatory. The Owner shall, in its sole discretion, have the right and option to enforce any claim it may have against the Contractor, or against any of the Subcontractors, Sub-subcontractors, Suppliers or Vendors of Contractor, through litigation. The Owner shall, in its sole discretion, also have the right and option to refuse to arbitrate any claim brought against Owner by the Contractor, either on Contractor's own behalf, or on behalf of any of the Subcontractors, Sub-subcontractors, Suppliers or Vendors of Contractor, and demand that such claim be pursued through litigation. In the event the Owner exercises its right and option to refuse to arbitrate a claim brought against the Owner, written notice of such refusal shall be given by Owner to the party making the claim and to any tribunal administering the claim at any time up to and including the date when Owner is required by any applicable statute, rule or order to respond to such claim.

§ 15.4.1 If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim shall be subject to arbitration unless the Owner decides to pursue the claim through litigation, which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. The Arbitration shall be conducted in the place where the Project is located, unless another location is mutually agreed upon. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.

§ 15.4.1.1 A demand for arbitration in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim.

§ 15.4.2 The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

§ 15.4.3 The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement, shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

§ 15.4.4 Consolidation or Joinder

§ 15.4.4.1 Limitation on Consolidation or Joinder. No arbitration arising out of or relating to the Contract shall include, by consolidation or joinder or in any other manner, the Architect, the Architect's employees or consultants, except by written consent containing specific reference to the Agreement and signed by the Architect, Owner, Contractor and any other person or entity sought to be joined. No arbitration shall include, by consolidation or joinder or in any other manner, parties other than the Owner, Contractor, a separate contractor as described in Article 6 and other persons substantially involved in a common question of fact or law whose presence is required if complete relief is to be accorded in arbitration. No person or entity other than the Owner, Contractor or a separate contractor as described in Article 6 shall be included as an original third party or additional third party to an arbitration whose interest or responsibility is insubstantial. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of a Claim not described therein or with a person or entity not named or described therein. The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

SECTION 01 10 00
SUMMARY OF THE WORK

PART 1 GENERAL

1.01 PROJECT

A. Project Name: Nelson Care Center Renovation
B. Owner's Name: Vivie
C. Architect's Name: Wold Architects and Engineers.
D. Additional Project contact information is specified in Section 00 01 03 - Project Directory.
E. The Project consists of the construction of a new entry canopy and remodeling.
   1. Briefly and without force and effect upon the Contract Documents, the Work can be summarized as follows:
   2. Work under this Contract includes:
      a. Sitework:
         1) Rough and finish grading, paving, concrete sidewalks.
         2) Miscellaneous site improvements.
      b. Building Structure:
         1) Concrete footings, concrete foundation walls, concrete slabs on grade, steel and wood framing.
      c. Building Enclosure:
         1) Aluminum windows, storefront entrance systems and glazing. Aluminum louvers.
         2) Roofing systems of fully adhered single ply, pre-finished metal coping, pre-finished metal roofing and asphalt shingles.
      d. Interior Finishes:
         1) Insulated gypsum board/metal stud partitions.
         2) Floor finishes of carpet, VCT, resilient sheet goods, tile.
         3) Wall finishes of paint, wallcovering, tile, plaster.
         4) Ceiling finishes of acoustical lay-in tile, gypsum board, gypsum board soffits, linear metal ceilings.
         5) Plastic laminate casework, architectural woodwork, HM door frames, wood doors, access panels, hardware, glazing, acoustic treatment, toilet accessories, signage, miscellaneous specialties.
      e. Mechanical Systems:
         1) Plumbing including, supply and waste piping systems, piping insulation, plumbing fixtures.
         2) Heating including piping, piping insulation.
         3) Ventilation to include, air handlers, ductwork, duct insulation, chilled water piping.
         4) Temperature control system.
      f. Electrical Systems:
         1) Electrical service, switchgear, distribution panels, conduit and wiring.
         2) Interior and exterior lighting. Parking lot lighting.
         3) Low voltage work to include: rough-in for Owner-provided systems.
         4) Fire alarm.
F. Keep Architect fully informed about progress of the work, performance of the work and potential problems.
G. The Owner will hold a wall breaking at the start of construction.

1.02 WORK BY OWNER THROUGH OTHER CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.
B. Preceding Work: Owner has awarded or will award separate contract(s) for the following construction operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
   1. Asbestos Abatement: A separate contract will be awarded for abatement of the following:
      a. VAT
      b. Asbestos pipe insulation
      c. Carpet and VAT underneath
      d. Asbestos fireproofing

C. Concurrent Work: Owner will award separate contract(s) for the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.
   1. Low voltage work to including security and nurse call including devices, cabling, and programming. Rough-ins and power by Contractor..

D. Owner will supply the following:
   1. Spa Tub.
   2. Residential Appliances.

E. Owner will supply the following for installation by Contractor:
   1. Refer to Accessory/Equipment Schedule on sheet A4.101.

1.03 OWNER OCCUPANCY

A. Owner intends to continue to occupy adjacent portions of the existing building during the entire construction period.

B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

C. Schedule the Work to accommodate Owner occupancy.

1.04 CONTRACTOR USE OF SITE AND PREMISES

A. Construction Operations: Limited to areas noted on Drawings.
   1. Locate and conduct construction activities in ways that will limit disturbance to site.
   2. Contractor is to visit site and be familiar with existing conditions. Contractor will be required to accept existing conditions on site prior to mobilizing.
   3. Conform to City's noise control regulations, including limited hours of construction operations.
   4. Do not allow construction waste and debris to accumulate on site; remove debris as it accumulates and, unless specified otherwise, dispose of legally off-site.
   5. Use of Existing Building: Maintain existing building in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

B. Arrange use of site and premises to allow:
   1. Owner occupancy.
   2. Work by Others.
   3. Work by Owner.
   4. Use of site and premises by the public.

C. Existing building spaces may not be used for storage.

D. Utility Outages and Shutdown:
   1. Provide the Owner with at least 28 days notice of Outages and Shutdowns.
   2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without advanced notice to Owner and authorities having jurisdiction.
   3. Prevent accidental disruption of utility services to other facilities.

1.05 LAYING OUT WORK

A. Locate all general reference points. Where dimensions or observed scope of work differ substantially from Drawings, notify Architect for decision.

B. Lay out Work from the reference points furnished and be responsible for all lines, elevations, and measurements inside workspace. Exercise proper precaution to verify figures shown on Drawings before laying out work and will be held responsible for any error resulting from his failure to exercise such precaution.

C. Call for public utility locates before starting any excavations.

D. Hire the services of a locator company to locate all privately owned utilities that may be disturbed by construction operations.

E. Coordinate utility connections with municipality/utility company in which project is being constructed.

1.06 WORK SEQUENCE

A. Construct Work in phases during the construction period as noted on the Phasing Plans.

1.07 SPECIFICATION SECTIONS APPLICABLE TO EVERY CONTRACT

A. Sections in Division 1 govern the execution of the Work of all items in the Technical Specification Sections.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 10 00

SECTION 01 23 00
ALTERNATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description of Alternates.
B. Acceptance of Alternates.
C. Schedule of Alternates.

1.02 DESCRIPTION OF ALTERNATES

A. This Section describes the limits of the requested alternates to the Contract work. Refer to the Product/Execution Articles of the appropriate Specifications and the Drawings for information pertaining to the work of each alternate.
B. Each proposal under an alternate shall include all incidental work and all adjustments necessary to accommodate the changes. All work shall meet the requirements of the Drawings, Specifications and appropriate details.
    1. Contractor is responsible for providing work if applicable to each alternate, whether or not an added or deducted cost is included on their bid form.
    2. Taxes which are applicable to work involved in alternates as well as costs, if any, for increased coverage of bonds and insurance shall be included.
    3. Each Bidder shall examine the Drawings and Specifications to determine the extent to which their work is affected by bid alternates. Include in the space provided on the bid form the cost of any added or deducted work resulting from each alternate.
C. Submit each alternate proposal as an individual cost for the particular alternate and shall be proposed under the premise that no other alternates have been accepted. Should the work of an alternate called for by the Bid Form not affect the cost of the work, state "No Change" in the space provided. If an alternate is left blank, the Owner reserves the right to throw out the entire bid or interpret the alternate as "No Change".

1.03 ACCEPTANCE OF ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner-Contractor Agreement or by Change Order if agreed upon by the Contactor after the Award of the Contract.
B. The Owner will accept Alternates in the order that they appear in the Schedule of Alternates.
C. Any of the alternates may be accepted by Owner and will be used in determining the low bidder.
D. Owner may, at their option, vary the scope of the work by authorizing alternates which will add to the work, deduct from the work or substitute materials, equipment or methods.

1.04 SCHEDULE OF ALTERNATES

A. Alternate No. 1 - North Parking Lot
    1. Provide a cost to provide and install the work as shown. Refer to Civil Drawings.
    2. Base scope: No work in this area.
B. Alternate No. 2 - West Short-Stay Parking Lot
    1. Provide a cost to provide and install the work as shown. Refer to Civil Drawings.
    2. Base scope: No work in this area.
C. Alternate No. 3 - Southwest Parking Lot
    1. Provide a cost to provide and install the work as shown. Refer to Civil Drawings.
    2. Base scope: No work in this area.
D. Alternate No. 4 - East Employee Parking Lot
    1. Provide a cost to provide and install the work as shown. Refer to Civil Drawings.
    2. Base scope: No work in this area.
E. Alternate No. 5 - Parking Lot Light Pole Replacement
    1. Provide a cost to provide and install the work as shown. Refer to Civil and Electrical Drawings.
    2. Base scope: Existing Parking Lot light poles to remain.

F. Alternate No. 6 - Roofing at Short-Stay and Admin Wings
   1. Provide a cost to provide and install the work as shown. Refer to Roof Plans.
   2. Base scope: Existing roof to remain (except where modified as part of base scope of work).

G. Alternate No. 7 - Replacement of Area A Link Doors and Frames
   1. Provide a cost to provide and install the work as shown. Refer to Floor Plans.
   2. Base scope: Existing doors and frames to remain at Area A Link.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 IMPLEMENTATION

A. If the Owner elects to proceed on the basis of one or more of the alternates, make all modifications to the Work required in the furnishing and installation of the selected alternate or alternates subject to the approval of the Architect at no additional cost to the Owner except as proposed in the Bid.

B. Coordinate pertinent related work and modify surrounding work as required to properly integrate the work under each alternate, and to provide the complete construction required by Contract Documents.

C. If so stated in the Agreement, or modifications thereto, provide alternate materials, equipment and/or construction as specified.

END OF SECTION 01 23 00

SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. **PRODUCT OPTIONS NOT REQUIRING PRE-BID SUBMITTAL**

1. Where a single manufacturer is specified and acceptable manufacturer are also listed, acceptable manufacturers must provide an identical product or accept responsibility for all design implications when providing a product other than the specified product.
2. Where products are specified by reference standards, any product established by a material testing agency to meet these standards is acceptable.
3. Where multiple manufacturers and associated models are specified, select any one named.
4. Where manufacturer(s) alone are specified, select any manufacturer and the product recommended in writing by the manufacturer as most suited to the application shown on the Drawings and Specifications.
5. Where the phrase "or equal" or "equivalent" follows the name of a manufacturer, any product which meets the performance and appearance standards established by the specified manufacturer may be selected, subject to the Architect's acceptance.
6. Where a manufacturer is listed in both a technical specification section and the Interior Material Finish/Color Schedule, on the Drawings and a color is provided.

B. **PRODUCT SUBSTITUTIONS REQUIRING PRE-BID SUBMITTALS**

1. Step One - Manufacturers Substitution Request
   a. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
      1) Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
      2) Agrees to provide the same warranty for the substitution as for the specified product.
      3) Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
      4) Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
      5) Waives claims for additional costs or time extension that may subsequently become apparent.
   b. Attached Substitution Request Form is submitted ten (10) calendar days prior to the bid date with the following information:
      1) Specified manufacturer's model numbers and proposed manufacturer's product literature, noting product numbers for proposed substitutions, and where appropriate, samples and data relating to construction details.
         (a) Clearly indicate on the literature what product is being submitted for substitution.
         (b) If submitted literature does not match the requirements of the specified product, submit a letter stating proposed manufacturer will custom make products to meet specified product.
2. Step Two - Manufacturers Acceptance
   a. Individual specification sections may be amended by the Architect during the bid period to include additional names of manufacturers determined to be capable of providing acceptable materials.

b. The Interior Material Finish/Color Schedule, on the Drawings or Specifications may be amended by the Architect during the bid period to include colors by manufacturers listed in technical sections, but not noted on the Interior Material Finish/Color Schedule, on the Drawings or in the Specifications.
c. Architect's acceptance is based upon his determination that a manufacturer is capable of supplying acceptable materials. Approval is not assured or implied for a specific material, item of equipment, color or finish.
d. Official notification will be by addendum to the Contract Documents.

3. Step Three - Product Acceptance
   a. Upon award of a construction contract, accepted manufacturers may submit for review to the Architect through the General Contractor or Construction Manager, specific products, materials or equipment items as substitutes for those specified.
      1) Contractor to provide letter stating they will reimburse Architect to review substitutions.
   b. Architect will review substitute products for performance, appearance, color, finish, size and suitability for inclusion in the work. If a substitute product is not accepted, submit another product by the same or other accepted manufacturer or provide the specified product.
   c. Match specified colors and dimensions exactly, whether or not they are standard with the substitute product, unless a minor variation is accepted by the Architect.
   d. If a substitute product is accepted, coordinate any necessary changes in other related work and pay for these changes.
      1) Pay cost of architectural or engineering services, if any, required to incorporate substitute products in the Work.

C. **SUBSTITUTIONS BY CHANGE ORDER AFTER CONTRACT AWARD**

1. A substitution for a specified product may be permitted by a no cost or deduct change order to the Owner if product proposed is determined to be equivalent in performance and suitability, and if at least one of the following conditions apply:
   a. Owner is given a credit for the work.
   b. Product is of superior quality than product specified.
   c. Product color or finish selection is preferable.
   d. Products specified and upon which building is designed have been discontinued by manufacturer.
2. Provide Architect, through Owner, reasonable compensation for product evaluation.

3.02 ATTACHMENTS

A. A Substitution Request Form required to be used on the Project is included after this section.

END OF SECTION 01 25 00

SECTION 01 25 01
PRE-BID SUBSTITUTION REQUEST FORM

SUBMITTAL TO ARCHITECTS/ENGINEERS OFFICE

To:

Wold Architects and Engineers
Minneapolis, Minnesota
Via: mail@woldae.com

PROJECT INFORMATION

Project Owner: Vivie
Project Name: Nelson Care Center Renovation

PRE-BID SUBMITTAL REQUEST INFORMATION

Date: _____

Specification

Name: _____

Section Number: ____ ____ ____

Paragraph/Article: _____

Proposed Substitution Manufacturer:

Manufacturer Website: www._____._____

Proposed Product

Name: _____

Model: _____

CERTIFICATION

The undersigned/manufacturer certifies they agree with the following:

1. I am the manufacturer or an authorized manufacturer's representative.
2. The proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
3. Literature has been submitted with the product and components clearly indicated. Any items that are different than the specification are noted.
4. Provide the same warranty for the substitution as for the specified product.
5. Provides the same or equivalent maintenance service and source of replacement parts, as applicable.
6. To coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to the Owner.
7. Waives claims for additional costs or time extension that may subsequently become apparent.

Submitted by:

Name printed clearly: _____

Firm: _____

Address:_____

_____

Telephone: _____

Email:_____

END OF SECTION 01 25 01

SECTION 01 26 63
CHANGE ORDERS

PART 1: GENERAL

1.01 CHANGE ORDER PROCEDURES

A. Changes in the Project scope of work affecting the project cost can be made only through AIA Document G701 - Change Order.
   1. The procedures for processing changes in the scope of Work are listed as follows:
   2. The Architect prepares one of the following documents to modify the scope of work. Documents and attachments revising the drawings and specifications will be distributed electronically and the Contractor will be responsible for printing.
      a. Supplemental Instructions (SI) which are used for no cost changes.
      b. Proposal Request (PR) to be used for proposed changes that need written approval on cost prior to proceeding.
      c. Construction Change Directive AIA Document G714 (CCD) which is used when the work must proceed immediately and time and material cost submitted as soon as possible for review by the Architect.
   3. The Contractor reviews and responds as follows:
      a. Supplemental Instructions (SI): This no cost change is to be carried out in accordance with the following modifications to the contract documents described herein. If this change effects cost, do not proceed with this change. Notify the Architect in writing within 10 days of receipt that an itemized (labor and material) quotation will be submitted within 21 days of initial receipt of this Supplemental Instruction. If a cost is not submitted within 21 days, this Supplemental Instruction will be accepted at no additional cost.
      b. Proposal Request (PR): Submit an itemized (labor and material) quotation for the proposed modifications to the contract documents as described herein within 21 days of receipt. If a cost is not submitted within 21 days, this Proposal Request can be accepted at no additional cost. Written approval is required prior to proceeding with this change.
      c. Construction Change Directive AIA Document G714 (CCD): Proceed immediately to carry out this change in the contract documents as described herein. If this revision effects cost, submit an itemized (labor and material) quotation within 21 days of receipt. If a cost is not submitted within 21 days this Change Directive will be accepted at no additional cost.
   4. The Architect will review the Contractor’s labor and material itemized quotation and respond in writing whether it is acceptable or needs revision. When all pricing is accepted by the Architect and Owner, a Change Order will be processed. Change Orders will be processed at increments determined by the Architect throughout the construction schedule.

B. See the General Conditions of the Contract for Construction for methods of determining cost or credit, mark-up and schedule on submitting claims.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION 01 26 63

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General administrative requirements.
B. Electronic document submittals.
C. Preconstruction meeting.
D. Progress meetings.
E. Schedule of Values.
F. Coordination drawings.
G. Submittals for review, information, and project closeout.
H. Requests for Information (RFI) procedures.
I. Submittal procedures.

1.02 PROJECT COORDINATOR

A. Project Coordinator: Construction Manager.
B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices, for building access, traffic, and parking facilities.
C. During construction, coordinate use of site and facilities through the Project Coordinator.
D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
E. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities. Responsibility for providing temporary utilities and construction facilities is identified in Section 01 10 00 - Summary of the Work.
F. Coordinate field engineering and layout work under instructions of the Project Coordinator.
G. Make the following types of submittals to Architect through the Project Coordinator:
    1. Requests for Information.
    2. Shop drawings, product data, and samples.
    3. Test and inspection reports.
    4. Applications for payment and change order requests.
    5. Coordination drawings.
    6. Correction Punch List and Final Correction Punch List for Substantial Completion.
    7. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTAL

A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF) format, as appropriate to the document, and transmitted via email the architect's staff assigned to the project.
    1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Information (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
    2. It is Contractor's responsibility to submit documents in allowable format.
    3. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.

3.02 LIST OF MATERIALS

A. Within 7 days after the award of the Contract (notice to proceed or letter of intent), submit a complete list electronically of all material, products, and equipment proposed to be used in construction to the Architect for acceptance.
   1. Do not order materials until the proposed listed materials, products and equipment to be used in construction are accepted by the Architect.

B. Where two or more makes or kinds of items are named in the specifications (or additional names are called for in addenda), the Contractor shall state which particular make or kind of each item they proposes to provide. If the Contractor fails to state a preference, the Owner shall have the right to select any of the makes or kinds named without change in price.

C. This list shall be arranged generally in order of specification sections. The items listed shall fully conform to project requirements and specifications. All materials are subject to the Architect's acceptance.
   1. After acceptance, changes or substitutions will not be permitted.

D. Clearly identify or list the material, product or equipment by manufacturer and brand by listing the names for all items, including those where only one material or product is specified. Each and every material, product and equipment shall be specifically named, not listed "as specified".

3.03 LIST OF SUBCONTRACTORS

A. Immediately after Contract award submit a subcontractor and supplier list.
   1. Propose use of subcontractors or sub-subcontractors who are established, reputable firms of recognized standing with a record of successful and satisfactory past performance. Include the following information: specification section, item of work, subcontractor or supplier, material/manufacturer (as specified will not be allowed), project manager, phone and email. List major sub-subcontractors for mechanical and electrical work. Use only those subcontractors (and sub-subcontractors, when appropriate) who are acceptable to the Architect and Owner on the Work.

B. Prior to contract award, submit electronically a signed and notarized Minnesota Responsible Contractor Compliance Affidavit from each subcontractor as outlined in the General Conditions of the Contract for Construction.
   1. Changes to subcontractors during the project will require a resubmittal of a Minnesota Responsible Contractor Compliance Affidavit.

3.04 SCHEDULE OF VALUES

A. Requirements
   1. Submit Schedule of Values to Architect ten (10) days prior to first Application For Payment (AIA Form G702, G702a).
      a. For Contracts with multiple buildings, break down Schedule of Values by building.
      b. For projects with multiple phases, break down Schedule of Values by phase.
      c. Break down labor and material separately.
      d. Round off amounts to nearest ten dollars.
      e. Provide separate line items for each of the following items:
         1) Operations and Maintenance Manuals, equaling of 0.125% of Contract value.
         2) As-Built Drawings, equaling of 0.0625% of Contract value.
         3) Training, equaling of 0.125% of Contract value.
         4) Attic Stock Materials, equaling 0.0625% of Contract value.
         5) Mechanical and Electrical Coordination Drawings, equaling 0.0625% of Contract value.
   2. Use Schedule of Values only as basis for Contractor's Application For Payment.

B. Form of Submittal
   1. Base format on Sections listed in Section 00 01 10 - Table of Contents, as well as, the Mechanical Electrical, Communications and Security Table of Contents. Break down labor and material separately.

3.05 CONSTRUCTION SCHEDULES

A. Refer to Section 01 32 16 - Construction Progress Schedule.

3.06 PRECONSTRUCTION MEETING

A. Schedule meeting within 15 days after Notice to Proceed.

B. Attendance Required:
   1. Owner's representative.
   2. Architect and their consultants.
   3. Contractor's Project Manager and Site Superintendent.
   4. Major Subcontractors.
   5. Major Suppliers.
   6. Others as appropriate.

C. Agenda:
   1. Distribution and discussion of:
      a. List of subcontractors.
      b. List of major suppliers.
      c. Projected construction schedules.
      d. Submittal schedule.
      e. Scheduling of pre-installation conferences.
   2. Project coordination and scheduling:
      a. Designation of responsible personnel representing the Owner, Contractor, Architect and Architect's Consultants.
      b. Major equipment deliveries and priorites, including expected submittals for such.
      c. Critical work sequencing.
      d. Mock-up Panels.
      e. Temporary utilities.
      f. Use of onsite utilities.
   3. Procedures and processing of: field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
      a. Status of Building Permit and:
         1) Steel Fabricator Certification.
         2) Special Inspection Form.
      b. Field decisions.
      c. Submittals.
         1) Mechanical and Electrical Coordination drawings.
      d. Product substitutions.
      e. Applications for payments.
      f. Time limit on claims of 21 days.
      g. Proposal Requests and Supplemental Instructions.
      h. Change Orders.
      i. Scheduling activities of a Geotechnical Engineer.
   4. Procedures for maintaining Record Documents.
   5. Use of Premises:
      a. Office, work and storage areas.
      b. Owner's requirements.
   6. Construction facilities, controls and construction aids.
      a. Construction Dust Control and Periodic Cleaning:
         1) Submittal of work area and procedures schedule.
         2) Dust proof enclosures.
         3) HEPA filters on vacuums.
         4) Maintaining negative air flow.
         5) Dust control by watermist of surfaces.
         6) Debris removal weekly.
         7) Daily cleaning requirements.

b. Failure to Comply.
1) A written warning will be issued for correction.
(a) If correction notice is not complied within 8 hours, Owner may stop work or take over cleaning.
(b) Cost will be borne by Contractor.
c. Final Cleaning:
1) Schedule in time for Owner to complete furniture installation, and cleaning/waxing of floors.
2) Any cleaning done by the Owner due to unacceptable cleaning by the Contractor, or not proceeding in a timely fashion will be back charged to Contractor.
7. Contractor to record minutes and distribute copies within two days after meeting to participants, with electronic copies to Architect, Owner, participants, and those affected by decisions made.

3.07 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the work at regular intervals and as required due to the progress of the work.
B. Hold called meetings at the Contractor's project field office.
C. Attendance Required:
1. Contractor.
2. Owner.
3. Architect may attend as needed.
4. Architect' consultants may attend as needed.
5. Contractor's superintendent.
6. Subcontractors appropriate to the progress of the work.
7. Suppliers and manufacturer's representatives as appropriate to the agenda.
D. Agenda:
1. Review and approval of minutes from previous meetings.
2. Review of work progress since previous meeting.
3. Field observations, problems, and decisions.
4. Identification of problems that impede, or will impede, planned progress.
5. Review of submittals schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period before the next meeting.
10. Maintenance of quality and work standards.
11. Effect of proposed changes on progress schedule and coordination.
12. Other business relating to work.
E. Contractor to record minutes and distribute copies within two days after meeting to participants, with electronic copies to Architect, Owner, participants, and those affected by decisions made.

3.08 COORDINATION DRAWINGS

A. Refer to "Common Work Results" in Mechanical and Electrical Specifications for requirements.
B. Prior to construction occurring above grade plane, submit Mechanical/Electrical Coordination Drawings for design team review.

3.09 REQUESTS FOR INFORMATION (RFI)

A. Definition: A request seeking one of the following:
1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.

C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
   1. Prepare a separate RFI for each specific item.
      a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
      b. Do Not forward requests which solely require internal coordination between subcontractors.

D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
   1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
   2. Unacceptable Uses for RFIs: Do not use RFIs to request the following::
      a. Approval of substitutions.
      b. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
      c. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
   3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
   4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question.
      a. They will be rejected.
      b. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.

E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
   1. Official Project name and number, and any additional required identifiers established in Contract Documents.
   2. Discrete and consecutive RFI number, and descriptive subject/title.
   3. Issue date and requested reply date no sooner than 7 working days.
   4. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
   5. Annotations: Field dimensions and/or description of conditions which have engendered the request.
   6. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

G. Review Time: Architect will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
   1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.

3.10 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
   1. Product data.
   2. Shop drawings.

3. Samples for selection.
4. Samples for verification.

B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
   1. Prepare clearly identified shop drawings or schedules to this specific project, containing only data applicable. Include with the shop drawings or schedules a letter of transmittal listing and dating the submitted drawings in sets.
   2. Contractor to review all submittals prior to submittal to Architect, and indicate such review with a stamp and signature. Review submittals for conformance to Drawings, Specifications, coordination with other trades and adjacent construction and verification of field dimensions. Failure of Contractor to adequately review submittals shall be cause for rejection.
   3. Prepare and submit electronically (with exception for color charts and samples) to Architect for review, all shop drawings and manufacturers catalog sheets showing illustrated cuts of items to be furnished, scale details, sizes, dimensions, performance characteristics, capacities, wiring diagrams, weights and arrangements. Each submittal to include a transmittal on contractor letterhead. Submittal to be in the form of one combined PDF, labeled with project name, professionally assembled so all documents are facing the same way.

C. If equipment other than that used in the design of this project is proposed to be used, the Contractor and/or supplier shall verify electrical differences, dimension variations and weight increases. The Contractor shall be responsible for any extra costs incurred as a result of equipment substitutions.

D. Samples will be reviewed for aesthetic, color, or finish selection.
   1. Unless otherwise specified, submit samples of size, and nature representing typical qualities. Where required, submit a sufficient number of samples to demonstrate the complete range of variations of the material or quality. Written acceptance of the Architect is required prior to ordering any item for which samples are required.

E. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.11 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
   1. Design data.
   2. Certificates.
   3. Test reports.
   4. Inspection reports.
   5. Manufacturer's instructions.
   6. Manufacturer's field reports.
   7. Other types indicated.

B. Submit for Architect's knowledge as contract administrator or for Owner.

3.12 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:
   1. Project record documents.
   2. Operation and maintenance data.
   3. Warranties.
   4. Bonds.
   5. Other types as indicated.

D. Submit Demonstration and Training recorded training modules.

E. Submit for Owner's benefit during and after project completion.

3.13 NUMBER OF COPIES OF SUBMITTALS

A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.

B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
   1. After review, produce duplicates.
   2. Retained samples will not be returned to Contractor unless specifically so stated.

3.14 SUBMITTAL PROCEDURES

A. General Requirements:
   1. Use a separate transmittal for each item.
   2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
   3. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
      a. When labeling shop drawings or product data, include the Specification Section number of where the product is specified for a submittal . For example, for cavity wall insulation Section 07 21 00 - Insulation does not require an insulation submittal, but Section 04 20 00 - Non-Bearing Unit Masonry does require that submittal.
   4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
      a. Submittals from sources other than the Contractor, or without Contractor's stamp will be rejected.
   5. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
      a. Deliver submittals to Architect via email.
      b. Submit samples to Architect's office, securely packaged, with the name of the Owner and Project clearly indicated on the package exterior. Each physical sample shall have a label or tag, firmly attached to the sample, bearing the following information: (a) Name of Owner and Project, (b) Name of Supplier, (c) Name of Contractor, and (d) Product information such as manufacturer's designation, finish, type, class, grade, etc. as is appropriate. The Architect will retain one copy of each sample.
      c. Deliver samples to Construction Manager at business address and submittals via email.
   6. Schedule submittals to expedite the Project, and coordinate submission of related items.
      a. When submitting multiple submittals at the same time, provide the Architect with a priority list for review.
      b. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
      c. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.
      d. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect's approval, allow an additional 30 days.
   7. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
   8. When revised for resubmission, identify all changes made since previous submission.
   9. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
   10. Submittals not requested will not be recognized or processed.

B. Product Data Procedures:
   1. Submit only information required by individual specification sections.
   2. Collect required information into a single submittal.
   3. Submit concurrently with related shop drawing submittal.
   4. Do not submit (Material) Safety Data Sheets for materials or products.

C. Shop Drawing Procedures:
    1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
    2. Do not reproduce Contract Documents to create shop drawings.
        a. Contractor is to generate shop drawings based on the information identified in the contract documents and notify the architect of discrepancies in the documents.
    3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:
    1. Transmit related items together as single package.
    2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.15 SUBMITTAL REVIEW

A. The Architect will take one of the following actions on submittals:
    1. “Reviewed”: Contractor shall proceed with ordering and/or fabrication.
    2. “Review Comments”: Contractor shall proceed with ordering and/or fabrication after taking into account noted comments.
    3. “Rejected”: Contractor shall provide a submittal that meets the intent of the specifications.
    4. “Revise and Resubmit”: Contractor shall modify submittal to address comments and resubmit.

B. Submittals for Information: Architect will not acknowledge receipt, and take no other action.

END OF SECTION 01 30 00

SECTION 01 31 26
ELECTRONIC BACKGROUND DOCUMENTS

PART 1 GENERAL

1.01 SUMMARY

A. The Architect will provide the Contractor with one (1) electronic copy of the background drawing relevant to their request. Requested files will be provided via email to the Contractor in AutoDesk AutoCAD format.

B. The terms and conditions on the attached form "Agreement Between Architect and Contractor for Transfer of Computer Aided Drafting (CAD) Files on Electronic Media" apply to all Electronic Documents issued by Wold Architects and Engineers or it's consultants for the project.

C. Exceptions:

1. Electronic Documents by Civil Engineer, Hagstrom Engineering, will need to sign an additional Agreement for Electronic File Transfer that can be made available upon request.

D. Electronic Document Availability

1. Pre Bid: AutoCAD backgrounds pertaining only to Survey and/or proposed grading will be available prior to bid. Requesting Contractors must complete "Attachment A - Agreement Between Civil Engineer and Contractor for Transfer of Computer Aided Drafting (CAD) Files on Electronic Media" at time of request.
2. After Bid: Backgrounds as requested by the awarded contractors at the discretion of the Architect or Engineer. Electronic Documents are available upon completion of "Attachment A - Agreement Between Architect and Contractor for Transfer of Computer Aided Drafting (CAD) Files on Electronic Media" by the:
    a. General Contractor on the project.
    b. Construction Manager on the project.

E. See attached form "Attachment A – Agreement Between Architect and Contractor for Transfer of Computer Aided Drafting (CAD) Files on Electronic Media."

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION 01 31 26

SECTION 01 31 27

ELECTRONIC BACKGROUND DOCUMENTS-ATTACHMENT A

AGREEMENT BETWEEN ARCHITECT AND CONTRACTOR FOR THE TRANSFER OF COMPUTER AIDED DRAFTING (CAD) FILES ON ELECTRONIC MEDIA

Nelson Care Center Renovation

The purpose of this agreement is to grant permission from the Transmitting Party (Architect and/or Engineer) to the Receiving Party (Contractor, Bidder, and/or Construction Manager) for the Receiving Party's use of Electronic Media on the Project, and to set forth the terms of such use. Electronic Media is defined to include all data or files transmitted. All Electronic Media is considered confidential and containing business proprietary information. Wold Architects & Engineers and its consultants grant the Receiving Party a limited license to use Electronic Media issued by Wold Architects & Engineers exclusively for this Project. The terms are set forth as follows:

The Electronic Media is transmitted for the Receiving Party's convenience and remains the sole property of Wold Architects and Engineers and/or its consultants.

1 The Transmitting Party makes no warranty, expressed or implied, including warranties of merchantability or fitness for a particular purpose, respecting the Electronic Media or the files therein. The Transmitting Party makes no representation regarding the accuracy, completeness, or permanence of the Electronic Media or the files therein.

2 The Electronic Media or files therein depict information only at the specific point in time of preparation and may not include final data or represent exact as-built conditions. Addenda information or revisions made after the date indicated on the files may not have been incorporated. The Receiving Party is solely responsible for verifying all field conditions against the Electronic Media or files therein and making all necessary adjustments. The Receiving Party is solely responsible for determining whether any changes made after it receives the Electronic Documents affect any services or work it provided using the Electronic Documents and for updating any such services or work.

3 The Electronic Media and files therein are not considered to be Contract Documents as defined by the General Conditions of the Contract for Construction. In the event of a conflict between the Architect's and/or Engineer's sealed Contract Drawings and the Electronic Media files, the sealed Contract Drawings shall govern. It is the Receiving Party's responsibility to determine if any conflicts exist.

4 Neither Wold Architects and Engineers nor its consultants are responsible for any decline in accuracy or readability due to the medium on which the Electronic Media are stored, or for any unintentional transmission of computer viruses.

5 The Electronic Media and the files therein may not be used by the Receiving Party for any purpose other than as a convenience in the preparation of Shop Drawings, layout, and other purposes related to the Project. Any use or reuse of the Electronic Media of the files therein, by the Receiving Party or others, are at the Receiving Party's sole risk and without liability or legal exposure to the Architect, Engineers, or their consultants.

6 The Architect reserves the right to determine what content will be distributed to the Receiving Party.

BY SIGNING BELOW, THE RECEIVING PARTY AGREES TO THE TERMS SET FOR BY THIS AGREEMENT.

AUTHORIZED ACCEPTANCE:

By Receiving Party/Contractor of Record

_____

Signature

_____

Print Name and Title

_____

Print Name of Company

_____

Date

END OF SECTION 01 31 27

SECTION 01 4100
REGULATORY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Codes

B. Laws

C. Rules

D. Fees

E. Permits

1.2 SUMMARY OF REFERENCE STANDARDS

A. Regulatory requirements applicable to this project are the following:

B. 28 CFR 35 - Nondiscrimination on the Basis of Disability in State and Local Government Services; Final Rule; Department of Justice; current edition.

C. 28 CFR 36 - Nondiscrimination by Public Accommodations and in Commercial Facilities; Final Rule; Department of Justice; current edition.

D. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.

E. 49 CFR 27, 37, and 38 - Transportation for Individuals with Disabilities; Final Rule; Department of Transportation; current edition.

F. FED-STD-795 - Uniform Federal Accessibility Standards (UFAS); 1988.

G. 29 CFR 1910 - Occupational Safety and Health Standards; current edition.

H. All applicable Federal, State, County and City codes and ordinances shall apply.

I. The Minnesota Plumbing Code, Minnesota Pollution Control Agency and Minnesota Department of Health requirements shall apply to all sewer and water construction.

1.3 LAWS

A. Regulatory Requirements should be met according to MnDOT Standard Specification for Construction - 2020 Edition, Section 1702.

B. Contractor shall notify all utility companies by means of the Gopher State One Call System prior to commencing work: (Gopher State # 800/252-1166).

1.4 RULES

A. Notify the Fire and police departments prior to work starting, prior to beginning work.

1.5 FEES

A. All costs incurred complying with the permits are incidental to the project unless otherwise noted.

1.6 PERMITS

A. The owner has secured the necessary permits for the project. The contractor is responsible for any bonds, insurance, or other permit requirements related to construction.

B. By signing the Proposal and completing the NPDES permit application, the Contractor is a co permitee with the Owner to ensure compliance with the terms and conditions of the General Storm Water Permit (MN R100001) and is responsible for those portions of the permit where the operator is referenced.

C. Notify the appropriate permitting authority in advance of the construction as required by the permits.

D. All costs incurred complying with the permits are incidental to the project unless otherwise noted.

E. The Contractor shall follow all provisions of the permits.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 45 33
STRUCTURAL TESTING AND SPECIAL INSPECTION

PART 1 GENERAL

1.01 INTENT AND CONDITIONS

A. Intent
   1. Define and coordinate structural testing and special inspection services.
   2. Provide a greater level of confidence that the specified work is constructed in compliance with the contract documents and the intent of applicable codes including Sections 1704 and 1705 of the International Building Code (IBC) as adopted by the current Minnesota State Building Code.
   3. Structural testing and special inspection services are intended to assist in determining probable compliance of the work with requirements specified. These services do not relieve the Contractor of responsibility for compliance with the requirements of the contract documents.

B. Conditions
   1. If inspection of a fabricator's work is required, the Owner's representative may require testing and inspection of the work at the plant, before shipment. Owner and Architect reserve the right to reject material not complying with the Contract Documents.
   2. Refer to individual technical specification sections for specific qualifications, inspections, tests, frequency and standards required. Testing and inspection shall be performed in accordance with the referenced standard for the specific material or procedure unless other criteria are specified. In the absence of a referenced standard, tests shall be performed in accordance with generally accepted industry standards.
   3. Work shall be checked as it progresses. Failure to detect any defective work or materials shall not prevent later rejection if defective work or materials are discovered, nor shall it obligate Owner to accept such work.
   4. Structural testing, special inspection, and periodic inspections by the Building Official do not preclude the normal field involvement and site observations by Architect or SER.
   5. Structural testing, special inspection, and periodic inspections by the Building Official do not relieve the Contractor of any responsibility to complete the work in accordance with the approved drawings and specifications.
   6. Testing agents and/or special inspectors may not waive or alter contract requirements, or approve or accept any portion of the work unless specifically authorized by the Architect or SER. They may not assume any duties of the Contractor, and they have no authority to stop or reject work.

1.02 RELATED DOCUMENTS

A. Drawings, Details of Construction, and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications apply to this section.

1.03 DEFINITIONS

A. Testing: Evaluation of systems, primarily requiring physical manipulation and analysis of materials, in accordance with approved standards.

B. Inspection: Evaluation of systems, primarily requiring observation and judgment.

C. Structural Special Inspections: Structural special inspections include inspections of structural items required by the IBC as adopted by the current Minnesota State Building Code, and other items, which in the professional judgment of the Structural Engineer of Record, are critical to the integrity of the building structure and are indicated to be performed under the requirements of this section. They do not include special inspections for non-structural items such as fireproofing, EIFS, and smoke control systems.

D. Structural Testing: Structural testing includes those tests of structural items required by the IBC as adopted by the current Minnesota State Building Code, or its referenced standards, and other tests, which in the professional judgment of the Structural Engineer of Record, are critical to the integrity of the building structure and are indicated to be performed under the requirements of this section.

E. Architect of Record: The prime consultant in charge of overall design and coordination of the project.

F. Structural Engineer of Record (SER): The licensed professional engineer in responsible charge of the structural design for the project.
G. Licensed Structural Engineer: A professional engineer with education and experience in the design of structures similar to this project licensed to practice in the State in which the Project is located.
H. Testing Agency (TA): The properly qualified firm performing testing services.
I. Special Inspector (SI): A properly qualified individual or firm performing special inspections.
J. Building Official: The officer or his or her duly authorized representative charged with the administration and enforcement of the building code for the project.

1.04 REFERENCES

A. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation; 2017.
B. ASTM C1093 - Standard Practice for Accreditation of Testing Agencies for Masonry; 2022.
C. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction; 2019.
D. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2021.
E. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2021.
F. International Building Code (IBC); 2018.
G. Minnesota State Building Code; 2020.

1.05 QUALIFICATIONS

A. Testing Agency: An approved independent testing agency acceptable to the Owner, Architect, and SER and meeting the following:
   1. Authorized to operate in the State in which the Project is located and experienced with the requirements and testing methods specified in the Contract Documents.
   2. Meet applicable requirements of References stated in Part 1, paragraph 4.
   3. Have available testing equipment that is calibrated, at reasonable intervals, by devices of accuracy traceable to either the National Bureau of Standards, or to accepted values of natural physical constants.
   4. Provide individuals performing tests and taking samples with appropriate certifications for work performed.
B. Special Inspector: Either an appropriately certified inspector or a civil/structural engineer performing under the direct supervision of a licensed structural engineer (as defined earlier in this section) and acceptable to the SER and Building Official. Unique special inspector requirements, for specific materials and systems, are noted in related technical specification sections.

1.06 RESPONSIBILITIES

A. Special Inspectors:
   1. Inspect the work assigned for conformance with the building department approved plans, specifications, and applicable material and workmanship provisions of the code. Perform inspection in a timely manner to avoid delay of work.
   2. Bring nonconforming items to the immediate attention of the contractor for correction. If not corrected within 24 hours or if inspector will not be on site the following day, bring to the attention of the SER by the end of the business day. If uncorrected after a reasonable period of time, bring to the attention of the Building Official, and to the Architect. Notify SER immediately if non-conforming items are enclosed, embedded, or obscured prior to verification of correction.
   3. Submit inspection reports to the Building Official, Contractor, the Architect, the SER, and other designated persons in accordance with the structural testing and special inspection schedule.
   4. Submit a final signed report stating whether the work requiring special inspection was, to the best of his/her knowledge, in conformance with the approved plans, specifications and the applicable workmanship provisions of the code.

5. Sign the Statement of Special Inspections in conjunction with other responsible parties.
6. Attend preconstruction meeting to review scope of special inspection.

B. Testing Agency:
1. Test the work assigned for conformance with the building department approved plans, specifications, and applicable material provisions of the documents. Perform tests in a timely manner to avoid delay of work.
2. Submit test reports to the Building Official, Contractor, the Architect, the SER, and other designated persons in accordance with the structural testing and special inspection schedule.
3. Sign the Statement of Special Inspections in conjunction with other responsible parties.
4. Attend a preconstruction meeting to review scope of structural testing.

C. Contractor:
1. Attend a preconstruction meeting to review scope of structural testing and special inspection.
2. Post or make available the structural testing and special inspection schedule within its office at the job site. Also, provide adequate notification to those parties designated on the schedule so they may properly prepare for and schedule their work.
3. Provide special inspectors access to the approved plans and specifications at the job site.
4. Review all reports issued by special inspectors.
5. Retain, at the job site, all reports submitted by the special inspectors for review on the Building Official's request.
6. Correct deficiencies identified in inspection or testing reports in a timely manner.
7. Provide safe access to the work requiring inspection or testing.
8. Provide labor and facilities to provide access to the work, to obtain, handle and deliver samples, to facilitate testing and inspection and for storage and curing of test samples.
9. Verify conformance of the work with specified construction tolerances.
10. Inspections by Building Official: Provide adequate notice for inspections performed by the building official, to comply with the Minnesota State Building Code and local ordinances.
11. Sign the Statement of Special Inspection in conjunction with other responsible parties prior to commencing construction.

D. Fabricator:
1. Submit a Certificate of Compliance to the Building Official, Special Inspector, and SER that the work was performed in accordance with the approved plans and specifications.
2. Sign the Statement of Special Inspection in conjunction with other responsible parties prior to commencing construction.

E. Owner:
1. Establish direct funding to provide for cost of structural testing and special inspection services.
2. Provide special inspector with approved plans, specifications and approved shop drawings.
3. Provide special inspectors and testing agencies with full access to the site at all times.
4. Sign the Statement of Special Inspection in conjunction with other responsible parties.

1.07 PAYMENT

A. Owner or Architect/SER, acting as the Owner's agent, will employ and pay for services of the special inspectors and testing agency to perform required structural testing and special inspection.

B. Unless noted otherwise, the Contractor shall provide and pay for all materials, samples, mock-ups, and assemblies required for testing and inspection and shall pay for shipping costs related to delivery of such items. Testing agency will pay for shipping costs of samples transported from site to lab.

C. If items requiring testing or inspection are enclosed, embedded or obscured prior to testing or inspection or if such items are placed without tests or inspections, the Contractor shall pay for the costs of any exploratory work deemed necessary by the Architect/SER to verify compliance with the Contract Documents.

D. Contractor shall pay for the costs of any retests or re-inspections caused by work that does not comply with the Contract Documents based on initial tests or inspections, or work that is later revised or replaced by the Contractor. This does not include revisions requested by the Owner.

1.08 INSPECTION NOTICE

A. Provide minimum of 24 hours notice for all items requiring testing or inspection. Items requiring testing and inspection services prior to or during placement shall not be placed until testing and inspection services are available. Items requiring testing and inspection services after placement shall not be enclosed or obscured until testing and inspection services are performed.

1.09 REPORTS

A. Testing agency and special inspectors shall submit reports for structural testing and special inspection in a timely manner to the Contractor, Building Official, SER, and Architect of Record. Provide reports of daily activities to the SER and Contractor. Submit reports to the Contractor on a daily basis and to the SER on a daily or weekly basis. Provide summary reports to the Building Official and Architect on a monthly basis unless they request otherwise.

B. Provide reports for ongoing work, containing the following information:

1. Date issued.
2. Project title and number.
3. Firm name and address.
4. Name and signature of tester or inspector.
5. Date and time of sampling, test, or inspection.
6. Identification of product and specification section.
7. Location in project, including elevations, grid location and detail.
8. Type of test or inspection.
9. Whether test specimens, test results or observations indicate compliance with Contract Documents. Specifically state any discrepancies
10. Types and locations of discrepancies found in work
11. Work required performed to correct discrepancies and work performed to correct previously noted discrepancies. Discrepancies corrected during an inspection need not be reported
12. Submit certified final special inspection report stating that, to the best of the special inspector's knowledge, the work requiring special inspection conformed to the Construction Documents.

1.10 FREQUENCY OF TESTING AND INSPECTION

A. For detailed requirements, see individual technical specification sections and the structural testing and special inspection schedule.

1.11 PROTECTION AND REPAIR

A. Upon completion of testing, sample-taking, or inspection, the Contractor shall repair damaged work and restore substrates and finishes to eliminate deficiencies, including deficiencies in the visual qualities of exposed surfaces, as judged solely by the Architect/SER. Protect work exposed by or for testing and/or inspection and protect repaired work. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for testing and/or inspection.

1.12 TESTS TO DEMONSTRATE QUALIFICATION

A. Any tests required to qualify the Contractor or the workers for any phase of the work, shall be performed at no additional cost to the Owner.

B. If the Contractor proposes a product material, method, or other system that has not been pre-qualified, the Architect/SER may require applicable tests to establish a basis for acceptance or rejection. The Contractor shall pay for these tests.

C. The Architect/Engineer of Record reserves the right to require certification or other proof that the system proposed is in compliance with specified tests, criteria or standards. A representative of an independent testing agency shall sign the certificate.

1.13 STATEMENT OF SPECIAL INSPECTIONS

A. The parties involved shall complete and sign the Statement of Special Inspection. Statement to be complete at time of permit issuance.

B. The completed Statement is an element of the construction documents and after permit issuance, becomes part of the building department approved plans and specifications.

END OF SECTION 01 45 33

Statement of Special Inspections

Project Name: Nelson Care Center Renovation

Location: 420 12th Ave E, Alexandria, MN 56308

Owner: Vivie

This *Statement of Special Inspections* is submitted as a condition for permit issuance in accordance with the Special Inspection and Structural Testing requirements of the 2018 International Building Code as adopted by the current Minnesota State Building Code. It includes a schedule of Special Inspection services applicable to this project and the identity of agencies to be retained for conducting these inspections and tests. Refer to individual technical specification sections listed in the summary schedule for specific qualifications, inspections, tests, frequency and standards required. This *Statement of Special Inspections* encompasses the following disciplines:

☒ Structural ☒ Architectural ☐ Other: _____

The Special Inspector shall keep records of all inspections and shall furnish inspection reports to the Building Official, the Architect, and Structural Engineer of Record. Discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official, the Architect, and SER. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

Interim reports shall be submitted to the Building Official, the Architect, and SER.

A *Final Report of Special Inspections* documenting completion of all required Special Inspections, testing and correction of any discrepancies noted in the inspections shall be submitted prior to issuance of a Certificate of Use and Occupancy.

ACKNOWLEDGEMENTS

Each appropriate representative shall sign below:

Owner:		Firm:	Vivie	Date:	
Contractor:		Firm:		Date:	
Architect:		Firm:	Wold Architects & Engineers	Date:	
SER:		Firm:	BKBM Engineers	Date:	
SI-S:		Firm:		Date:	
SI-T:		Firm:		Date:	
TA:		Firm:		Date:	
F:		Firm:		Date:	

If requested by engineer/architect of record or building official, the individual names of all prospective special inspectors and the work they intend to observe shall be identified.

Legend: SER = Structural Engineer of Record; SI-S = Special Inspector - Structural; SI-T = Special Inspector - Technical; F = Fabricator; TA = Testing Agency

Accepted for the Building Department By _____ Date _____

Testing and Special Inspection
Program Summary Schedule

Project Name Nelson Care Center Renovation Project No. _____

Location 420 12th Ave E

Alexandria, MN 56308 Permit No. _____ (1)

Technical (2) Section/Article	Description (3)	Type of Inspector (4)	Report Frequency (5)	Assigned Firm (6)
031000	Concrete Formwork	SI-S	Each Visit	
031510	Post-Installed Anchors	SI-T or SI-S	Each Visit	
032000	Concrete Reinforcement	SI-S	Each Visit	
033000	Cast-in-Place Concrete Tests	TA	Each Test	
033000	Cast-in-Place Concrete Inspections	SI-S	Each Visit	
051200	Steel Fabrication for non-AISC Certified Fabricators	SI-T	Each Visit	
051200	Structural Metal Framing – Field Welding and Bolting	SI-T	Each Visit	
053100	Steel Decking	SI-T	Each Visit	
075300	EPDM Membrane Roofing	SI-T	Each Visit	
076100	Sheet Metal Roofing	SI-T	Each Visit	
078400	Firestopping	SI-T	Each Visit	
079200	Joint Sealants	SI-T	Each Visit	
310000	Earthwork	SI-T	Weekly	

Notes: This schedule shall be filled out and included in the Structural Testing and Special Inspection Program.

(1) Permit No. to be provided by the Building Official.
(2) Referenced to the specific technical scope section in the program.
(3) Use descriptions per IBC Section 1705, as adopted by Minnesota State Building Code.
(4) Special Inspector - Technical, Special Inspector – Structural, Testing Agency.
(5) Weekly, monthly, per test/inspection, per floor, etc.
(6) Firm contracted to perform services.

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary utilities.
B. Temporary telecommunications services.
C. Temporary sanitary facilities.
D. Temporary Controls: Barriers, enclosures, fencing, and construction dust control.
E. Security requirements.
F. Waste removal facilities and services.
G. Field offices.

1.02 TEMPORARY UTILITIES

A. Owner will provide the following:
   1. Electrical power, consisting of paying for utility charges on existing services.
      a. Temporary power and lighting, refer to Div. 26.
   2. Water supply, consisting of paying for utility charges on existing services.
B. Contractor will:
   1. Engage appropriate local utility company to install temporary service or connection to existing service. Where the utility company provides only part of the service, provide the remainder of the service with matching, compatible materials and equipment, comply with utility company requirements.
      a. Arrange with the Utility Company, Owner and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.
      b. Provide adequate capacity at each stage of construction. Provide mobile power as needed before temporary power is connected.
      c. If required, obtain easements to bring temporary utilities to the project site, where Owner's easements cannot be used for that purpose.
C. Existing toilet facilities may not be used.
   1. Provide and maintain required sanitary facilities and enclosures. Provide at time of project mobilization.
   2. Maintain daily in clean and sanitary condition.
D. New permanent facilities may not be used.
   1. Provide and maintain required sanitary facilities and enclosures. Provide at time of project mobilization.
   2. Maintain daily in clean and sanitary condition.
E. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses as required by the local Fire Marshal or Building Official.
   1. If directed by the Building Official or Fire Marshal, provide fire watch with personnel acceptable to authorities until permanent fire-protection is activated.
   2. Provide temporary fire extinguishers, type and quantity as designated by local authorities.

1.03 TELECOMMUNICATIONS SERVICES

A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

1.04 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
B. Provide barricades and covered walkways required by governing authorities for public rights-of-way, exiting through the construction site and for public access to existing building.
   1. Review exiting that will be blocked with the local Fire Marshal and gain approval for exiting of those areas prior to blocking the exits.
C. Provide temporary fencing at the drip line for protection for plants and trees designated to remain. Replace damaged items.
D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.05 FENCING

A. Construction: Commercial grade chain link fence.

B. Provide 6 foot (1.8 m) high fence around construction site when designated on the site plan; equip with vehicular and pedestrian gates with locks.

1.06 EXTERIOR ENCLOSURES

A. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.07 INTERIOR PROTECTION

A. Provide temporary sound insulated partitions as indicated to separate work areas from the Owner's occupied areas, to prevent penetration of dust and moisture into the Owner's-occupied areas, and to prevent damage to existing materials and equipment.

B. Construction: Framing, fiberglass insulation and gypsum board over plywood sheet materials with closed joints and sealed edges at intersections with existing surfaces.

1. Maximum flame spread rating of 75 in accordance with ASTM E84.

C. Paint surfaces exposed to view from Owner-occupied areas.

D. Floor Protection:

1. Protect all carpet to remain with 3 mil self-adhering clear poly film utilizing tack water-based adhesive poly film guard in areas of construction.

E. Furniture and Equipment Protection:

1. Cover all furniture and equipment remaining in the space with polyethylene. Seal with tape to prevent dust/dirt from reaching the furniture and equipment.

F. Limit food and soft drink consumption to within the Contractor’s trailer or out of the building.

1.08 SECURITY

A. Provide security and facilities to protect Work, existing facilities, and the Owner's operations from unauthorized entry, vandalism, or theft.

1.09 VEHICULAR ACCESS AND PARKING

A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.

B. Coordinate access and haul routes with governing authorities and the Owner.

C. Provide and maintain access to fire hydrants, free of obstructions.

D. Provide means of removing mud from vehicle wheels before entering streets.

E. Designated existing on-site roads may be used for construction traffic.

F. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

G. Remove snow and ice as required to minimize accumulations and provide access to and throughout the site as required to complete the work/fire department access.

H. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion.

1.10 WASTE REMOVAL

A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

B. Provide containers with lids.

1. Debris shall be removed from the construction site and police exterior project site area on a weekly basis at a minimum to clean-up any wind-blown or excess construction materials or debris and dispose of in construction dumpsters to maintain a clean project site.

C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.

D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.11 HOUSEKEEPING

A. Do not allow debris to accumulate on-site or within the building work areas. The Contractor shall implement and provide the following cleaning services:
   1. Building Interior:
      a. Daily clean the entire interior floor of the building construction and renovation areas to remove visible dust and debris.
         1) Debris includes, but not limited to empty cartons and packaging, all building material scraps and other waste or refuse from the interior of the building and dispose of in the Contractor's construction dumpsters located outside the building.
         2) When sweeping is performed, utilize sufficient quantities of clean sweeping compound to control the air-borne dust.
         3) Sweeping compound shall not be used on finished floor systems or terrazzo floors.
      b. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.
      c. Owner occupied areas, with construction activity or adjacent to dustproof enclosures floors and walls that are contaminated by discharge or release from work area or by dust migration or transport shall be HEPA vacuumed on a daily basis.
      d. Once floor slabs are in place, walk-off mats shall be provided at all exterior entrances and at entrances to dustproof enclosure areas that are utilized by the workers.
         1) To prevent transport of dirt and debris to other surfaces or discharge into the air, mats shall be cleaned/HEPA vacuumed on a daily basis (more frequently if visible dirt and debris are observed) and change out mats on a monthly basis.
      e. Areas that workers have access to with final floor finish in place shall be HEPA vacuumed on a daily basis. Carpeted major circulation paths shall be covered with poly film guard. Replace poly film guard when it develops holes or tears as they occur. Poly film guard to be replaced if left in place over 45 days. Horizontal and vertical surfaces shall be wiped down as construction dust has accumulated.
      f. Where Contractor has periodic access to ancillary spaces occupied by Owner, thoroughly clean after each use, including HEPA vacuuming, so as to not disrupt Owner’s ongoing operations.
   2. Exterior/Site:
      a. On a daily basis:
         1) Broom clean the sidewalks to remove dust, loading dock/steps, at project construction personnel access locations, and material delivery or waste disposal locations.
         2) Remove debris from and police the exterior project site area to clean up any and remove windblown construction materials or debris or materials that could become windblown and dispose of in Contractor's construction dumpsters.
         3) Pickup and remove debris on the site from the work, including windborne debris that has blown onto site areas or adjacent property.
         4) Repair any damage to the temporary construction fence system.
         5) Repair damage to the site stormwater temporary erosion control system and storm water management systems.
      b. Weekly remove dust and debris from ledges.
      c. When visible dust and debris accumulate on site pavement, perform sweeping operations and related work to capture and remove those materials.

B. Failure to comply with housekeeping procedures.
   1. A written warning will be issued for correction by the Architect.
      a. If correction notice is not complied within 8 hours, Owner may take over cleaning.
      b. Cost will be back charged to the Contractor(s) by Change Order.

1.12 CONSTRUCTION DUST CONTROL

A. Provide Construction Dust Control on projects with areas occupied during construction, including dust producing construction during punchlist correction.

B. Air Quality Contaminant Control:
   1. Ventilate barricaded construction areas by use of fans to the outside of building.
   2. Maintain a minimum negative pressure of -0.01 inch (-0.254 mm) WC with door closed at barricade entrance openings by use of fans vented to outside of building.
      a. Rebalance air handling equipment to maintain correct airflow to occupied areas as required.
   3. Secure operable exterior windows and interior doors/windows not required for construction access as required to maintain negative pressure.
   4. Provide additional local exhaust during welding.

C. Dustproof enclosures:
   1. Install dustproof enclosures for work when required to protect areas occupied by the Owner from dust, debris and damage.
      a. Enclosures must be tight to cut off any flow of dust particles into occupied areas by sealing openings with tape or other impenetrable sealant to seal barrier wall seams, cracks around window and door frames, exhaust system ductwork, pipes, floor penetrations, joints and ducts.
   2. Block supply and return ventilation as to not recirculate air from construction area to air handlers supplying occupied areas or to prevent contamination of existing ductwork to remain.
   3. Install filters on exterior air handling equipment intakes adjacent to exhaust fans.
   4. For work creating dust outside of dustproof enclosures, provide temporary sealed enclosures around the work area.

D. Procedures:
   1. Contractor shall maintain all construction dust control devices throughout the construction period.
      a. Traffic between barricaded areas and open areas shall be kept to a minimum.
         1) Instruct workers to refrain from tracking dust into adjacent occupied areas or opening windows or doors allowing construction dust/airborne contaminants into adjacent occupied areas.
      b. Whenever possible, transport materials and refuse into an area from an external site without violating occupied areas.
      c. Execute work by methods to minimize raising dust from construction operations.
         1) Spray surfaces with water mist during dust-producing interior demolition activities.

1.13 FIELD OFFICES

A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.
B. Provide space for Project meetings, with table and chairs to accommodate 16 persons.
C. Locate offices a minimum distance of 30 feet (10 m) from existing and new structures.

1.14 OPERATION, REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
   1. Protect water piping from damage caused by freezing temperatures and similar elements.
   2. Maintain markers and protect underground utilities from damage during excavation operations.
B. Temporary Facility Changeover: Except for using permanent fire protection as soon as available, do not change over from using temporary security and protection facilities to permanent facilities until Date of Substantial Completion.
C. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
D. Remove underground installations to a minimum depth of 2 feet (600 mm). Grade site as indicated.
E. Clean and repair damage caused by installation or use of temporary work.
F. Restore existing facilities and exterior landscaping used during construction to original condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 50 00

SECTION 01 5713

TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.2 REFERENCE STANDARDS

A. MNDOT Standard Specification for Construction - 2020 Edition.

B. MPCA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit; current edition.

C. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit; Current Edition.

1.3 PERFORMANCE REQUIREMENTS

A. Comply with all requirements of Minnesota Pollution Control Agency (MPCA) for erosion and sedimentation control, as specified for the National Pollutant Discharge Elimination System (NPDES), under requirements for the current edition Construction General Permit (CGP).

B. Follow the Stormwater Pollution Prevention Plan (SWPPP) and submit inspection reports according to the SWPPP.

C. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
   1. Obtain and pay for permits and provide security required by authority having jurisdiction.
   2. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.

D. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
   1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.

E. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
   1. Control movement of sediment and soil from temporary stockpiles of soil.
   2. Prevent development of ruts due to equipment and vehicular traffic.
   3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

F. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
   1. Prevent windblown soil from leaving the project site.
   2. Prevent tracking of mud onto public roads outside site.
   3. Prevent mud and sediment from flowing onto sidewalks and pavements.
   4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

G. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
   2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

H. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

I. Open Water: Prevent standing water that could become stagnant.

J. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.4 SUBMITTALS

A. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

PART 3 EXECUTION

2.1 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

2.2 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

2.3 SCOPE OF PREVENTIVE MEASURES

A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.

B. Construction Entrances (if called out on Plans): Traffic-bearing aggregate surface.
   1. Width: As required; 15 feet, minimum.
   2. Length: 50 feet, minimum.
   3. Provide at each construction entrance from public right-of-way.
   4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.

C. Linear Sediment Barriers: Made of silt fences.
   1. Provide linear sediment barriers:
      a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
   2. Space sediment barriers with the following maximum slope length upslope from barrier:
      a. Slope of Less Than 2 Percent: 100 feet..
      b. Slope Between 2 and 5 Percent: 75 feet.
      c. Slope Between 5 and 10 Percent: 50 feet.
      d. Slope Between 10 and 20 Percent: 25 feet.
      e. Slope Over 20 Percent: 15 feet.

D. Storm Drain Inlet Protection (Sump or Curb): Protect each inlet using the details in the plans

E. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets, if required.

F. Soil Stockpiles: Protect downstream edge with linear sediment barrier.

G. Temporary Seeding: Use where temporary vegetated cover is required.

2.4 INSTALLATION

A. Traffic-Bearing Aggregate Surface:
   1. Excavate minimum of 6 inches.
   2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
   3. Place and compact at least 6 inches of 1 1/2 to 3 1/2 inch diameter stone.

B. Silt Fences:
   1. Store and handle fabric in accordance with ASTM D4873.
   2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
   3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.
   4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.
   5. Install with top of fabric at nominal height and embedment as specified.
   6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
   7. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.

C. Mulching Over Large Areas:
   1. Dry Straw and Hay: Apply 2-1/2 tons per acre; anchor using dull disc harrow or emulsified asphalt applied using same spraying machine at 100 gallons of water per ton of mulch.

D. Temporary Seeding:
   1. When hydraulic seeder is used, seedbed preparation is not required.
   2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
   3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft.
   4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft.
   5. Incorporate fertilizer into soil before seeding.
   6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
   7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
   8. Repeat irrigation as required until grass is established.

2.5 MAINTENANCE

A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.

B. Repair deficiencies immediately.

C. Silt Fences:
   1. Promptly replace fabric that deteriorates unless need for fence has passed.
   2. Remove silt deposits that exceed one-third of the height of the fence.

3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

D. Clean out temporary sediment control structures as required.

E. Place sediment in appropriate locations on site; do not remove from site.

2.6 CLEAN UP

A. Remove temporary measures after final stabilization has been achieved and has been approved by the City.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade, seed and finish to match adjacent ground surfaces.

D. Submit Notice of Termination of as indicated in the permit.

END OF SECTION

SECTION 01 70 00
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.
B. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.
C. Pre-installation meetings.
D. Cutting and patching.
E. Surveying for laying out the work.
F. Cleaning and protection.
G. Starting of systems and equipment.
H. Substantial Completion and Final Completion procedures, including Contractor's Correction Punch List, except payment procedures.

1.02 QUALIFICATIONS

A. For surveying work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate. Employ only individual(s) trained and experienced in collecting and recording accurate data relevant to ongoing construction activities,

1.03 COORDINATION

A. See Section 01 10 00 for occupancy-related requirements.
B. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
C. Notify affected utility companies and comply with their requirements.
D. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
E. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
G. Coordinate completion and clean-up of work of separate sections.
H. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

2.02 CLEANING MATERIALS

A. Cleaning materials as recommended by manufacturer of surface to be cleaned, as well as recommended by the cleaning material manufacturer for those materials being cleaned.
B. Vacuums that are HEPA rated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.

B. Require attendance of parties directly affecting, or affected by, work of the specific section.

C. Notify Architect thirty days in advance of meeting date.

D. Prepare agenda and preside at meeting:

1. Review conditions of examination, preparation and installation procedures.
2. Review coordination with related work.

E. Contractor to record minutes and distribute copies within two days after meeting to participants, with electronic copies to Architect, Owner, participants, and those affected by decisions made.

3.04 FINAL CLEANING COORDINATION MEETING

A. When requested by the Owner, the Construction Manager or General Contractor shall coordinate a final cleaning coordination meeting 30 days prior to the start of cleaning to establish the phasing of the areas to be final cleaned by the Cleaning Contractor and for reviewing the requirements of the final cleaning as required for Owner move-in.

B. Attendants:

1. Owner.
2. Architect.
3. Construction Manager or General Contractor.
4. Cleaning Contractor.

C. Cleaning Contractor in conjunction with the Construction Manager or General Contractor shall provide a detailed schedule, including a work plan, respective dates for each area and tasks for the work and quantity of personnel.

3.05 LAYING OUT THE WORK

A. Verify locations of survey control points prior to starting work.

B. Promptly notify Architect of any discrepancies discovered.

C. Contractor shall locate and protect survey control and reference points.

D. Control datum for survey is that indicated on drawings.

E. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

F. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
G. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
H. Utilize recognized engineering survey practices.
I. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
    1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
    2. Grid or axis for structures.
    3. Building foundation, column locations, ground floor elevations.
J. Periodically verify layouts by same means.
K. Maintain a complete and accurate log of control and survey work as it progresses.

3.06 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.07 ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
    1. Verify that construction and utility arrangements are as indicated.
    2. Report discrepancies to Architect before disturbing existing installation.
    3. Beginning of alterations work constitutes acceptance of existing conditions.
B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.
    1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 .
C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
    1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
    2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.
D. Remove existing work as indicated and as required to accomplish new work.
    1. Remove items indicated on drawings.
    2. Relocate items indicated on drawings.
    3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
    4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
    1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
    2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.

3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
    a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
    b. Provide temporary connections as required to maintain existing systems in service.
4. Verify that abandoned services serve only abandoned facilities.
5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.

F. Protect existing work to remain.
1. Prevent movement of structure; provide shoring and bracing if necessary.
2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
3. Repair adjacent construction and finishes damaged during removal work.

G. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
1. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect.
2. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
3. Where a change of plane of 1/4 inch (6 mm) or more occurs in existing work, submit recommendation for providing a smooth transition for Architect review and request instructions.

H. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.

I. Refinish existing surfaces as indicated:
1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.

J. Clean existing systems and equipment.

K. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.

L. Do not begin new construction in alterations areas before demolition is complete.

M. Comply with all other applicable requirements of this section.

3.08 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. See Alterations article above for additional requirements.

C. Perform whatever cutting and patching is necessary to:
1. Complete the work.
2. Fit products together to integrate with other work.
3. Provide openings for penetration of mechanical, electrical, and other services.
4. Match work that has been cut to adjacent work.
5. Repair areas adjacent to cuts to required condition.
6. Repair new work damaged by subsequent work.
7. Remove samples of installed work for testing when requested.
8. Remove and replace defective and non-complying work.

D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing.
1. In existing work, minimize damage and restore to original or specified condition.

E. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
G. Restore work with new products in accordance with requirements of Contract Documents.
H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
J. Patching:
    1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
    2. Match color, texture, and appearance.
    3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.09 PROTECTION OF INSTALLED WORK

A. See Section 01 50 00 - Temporary Facilities and Controls for temporary protective covering materials for flooring.
B. Protect installed work from damage by construction operations.
C. Provide special protection where specified in individual specification sections.
D. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
E. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
F. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
G. Protect work from spilled liquids. If work is exposed to spilled liquids, immediately remove protective coverings, dry out work, and replace moisture soaked materials.
H. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
I. Prohibit traffic from landscaped areas when possible. Repair when damaged.
J. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.10 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.
B. Coordinate start-up schedule with Architect and Owner prior to start-up of each item.
C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
E. Verify that wiring and support components for equipment are complete and tested.
F. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.11 DEMONSTRATION AND INSTRUCTION

A. See Section 01 79 00 - Demonstration and Training.

3.12 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.13 FINAL CLEANING

A. Execute final cleaning prior to Substantial Completion.
B. Use cleaning materials that are nonhazardous.
C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, grease, dust, fingerprints polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
F. Replace filters of operating equipment as specified in Division 23 specifications
G. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, and drainage systems.
H. Clean site; sweep paved areas, rake clean landscaped surfaces.
I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.
J. Coordinate with the Construction Manager or General Contractor to have marred surfaces repaired, patched or touched-up to match adjacent surfaces.
K. Maintain cleaning until the building or portion thereof, is occupied by the Owner.

3.14 SUBSTANTIAL AND FINAL COMPLETION PROCEDURES

A. Make submittals that are required by governing or other authorities.
    1. Provide copies to Architect and Owner.
B. Obtain and submit to the Architect a Certificate of Occupancy from AHJ.
C. Provide preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.
D. Notify Architect in writing when work is considered ready for Architect's Substantial Completion inspection.
E. Architect will visit the project to evaluate the request for issuance of a Certificate of Substantial Completion.
    1. If the Architect concurs that the Project is substantially complete, the Architect will deliver a Certificate of Substantial Completion and a list of work items necessary for completion or correction prior to request for inspection for final completion.
    2. If the Architect determines that the work is not substantially complete, the Architect will deliver to the Contractor a written statement including reasons.
F. Complete work on the items required by the Architect for achieving substantial completion and make additional written requests for issuance of a Certificate of Substantial Completion until the Architect determines that sufficient Work has been performed.
G. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.
H. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
I. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
J. When the punchlist work is considered complete, submit written certification that:
    1. When work is considered finally complete and ready for Architect's Final Completion inspection.
    2. The Building Permit has been finalized by the AHJ and submit a copy for the Architects and Owners record.

K. Architect will make an inspection to verify the status of completion with reasonable promptness after receipt of such certification.
    1. Should Architect consider that the Work is incomplete or defective:
        a. Architect will notify the Contractor in writing, listing the incomplete or defective work.
            1) Take immediate steps to remedy the stated deficiencies and send a second written certification to Architect that the Work is complete.
            2) Architect will reinspect the Work.
    2. Should Architect perform reinspection's due to failure of the Work to comply with the claims of status of completion made by the Contractor:
    3. Owner will compensate Architect for such additional services.
        a. Owner will deduct the amount of such compensation from the final payment.

END OF SECTION 01 70 00

SECTION 01 78 00
CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project record documents.
B. Operation and maintenance data.
C. Warranties and bonds.

1.02 SUBMITTALS

A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
B. Operation and Maintenance Data:
   1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
   2. Submit one copy of completed documents 15 days after Substantial Completion. This copy will be reviewed and returned, with Architect comments. Revise content of all document sets as required prior to final submission.
   3. Submit two sets of revised final documents in final form and one digital copy 60 days before final inspection.
C. Warranties, Bonds and other required forms:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
   2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
   3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.
D. Final Adjustment of Accounts.
   1. Make submittals within 30 days prior to final Application for Payment.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Change Orders and other modifications (accepted PR's, SI's and CCD's) to the Contract.
   4. Reviewed shop drawings, product data, and samples.
   5. Field test reports.
B. Ensure entries are complete and accurate, enabling future reference by Owner.
C. Store record documents separate from documents used for construction in a location protected from the weather.
D. Record information concurrent with construction progress.
E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions accepted during construction.
F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Label each set of Drawings "RECORD DOCUMENTS".
   2. Measured depths of foundations in relation to finish first floor datum.
   3. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   4. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.

5. Field changes of dimension and detail.
6. Details not on original Contract drawings.

G. Shop Drawings – Label each set by corresponding specification section. At the completion of the project, provide the Owner with one complete set, reviewed and stamped by architect, organized by specification section in the following formats:
1. Paper (various sizes) folded to 8 1/2" x 11" and boxed with project name and completion date clearly labeled on exterior.
2. Scanned PDF copy on a flash drive, ordered by specification section.

3.02 OPERATION AND MAINTENANCE DATA

A. Physical Format for Binders:
1. Commercial quality three-ring binders with durable , cleanable plastic cover in 8-1/2 x 11 inch (215.9 x 279.4 mm) size and maximum thickness of 2 inches (50.8 mm).
a. When multiple binders are used, correlate the data into related consistent groupings.
2. Manufacturer's printed data or typed pages on 20 pound (9.072 kg) weight white paper.
3. Provide fly-leaf for each separate product, or each piece of operating equipment.
a. Provide typed description of product, and major component parts of equipment.
b. Provide indexed tabs.
4. Identify each volume with typed or printed title "OPERATING, MAINTENANCE AND WARRANTY INSTRUCTIONS". Listing:
a. Title of Project
b. Identity of separate structure as applicable.
c. Identity of general subject matter covered in the manual.
5. Drawings:
a. Provide reinforced punched binder tab, bind in with text.
b. Fold larger drawings to the size of the text pages.

B. Digital Format:
1. Submit one PDF copy on a flash drive.

C. Content:
1. Arrange neatly typewritten table of contents for each volume, in the following systematic order.
a. Contractor, name of responsible principal, address and telephone number.
b. A list of each product required to be included, indexed to the content of volume.
c. List, with each product, the name, address and telephone number of:
1) Contractor or installer.
2) Maintenance contractor, as appropriate.
3) Identify the area of responsibility of each.
4) Local source of supply for parts and replacement.
5) Include warranty information as specified.
d. Identify each product by product name and other identifying symbols such as set in Contract Documents.
2. Product Data
a. Include only those sheets which are pertinent to the specific product.
b. Annotate each sheet to clearly identify the specific product or part installed.
3. Content, for moisture-protection and weather-exposed products:
a. Manufacturer's data, giving full information on products.
1) Applicable standards
2) Chemical composition
3) Details of installation
4) Instructions for inspection, maintenance and repair.
4. Additional requirements for maintenance data: The respective technical sections of the Project Manual.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

A. For Each Product, Applied Material, and Finish:
   1. Product data, with catalog number, size, composition, and color and texture designations.
   2. Information for re-ordering custom manufactured products.

B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.

C. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

A. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.

B. Where systems involve more than one specification section, provide separate tabbed divider for each system.

C. Binders: Commercial quality, 8-1/2 by 11 inch (216 by 280 mm) three D side ring binders with durable plastic covers; 2 inch (50 mm) maximum ring size. When multiple binders are used, correlate data into related consistent groupings.

D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.

F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.

G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.

H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

3.06 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after Substantial Completion. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized including:
   1. Contractor's Affidavit of Payment of Debts and Claims, AIA Document G706, with exceptions itemized by subcontractor and amounts owed each.
   2. Contractors Affidavit of Release of Liens, AIA Document G706A.
   3. Consent of Surety to Final Payment on Consent of Surety Company to Final Payment, AIA Document G707.
   4. Warranties and Bonds.
   5. Energy Rebate Applications and specified back-up.
   6. Minnesota Department of Revenue Tax Administration Form IC134, indicating compliance with Minnesota Statute 290.92: Tax Withheld at Source Upon Wages; Other Payments.

3.07 FINAL ADJUSTMENT OF ACCOUNTS TO FINAL PAYMENT

A. Submit a final statement of accounting to the Architect.

B. Statement shall reflect all adjustments to the Contract Sum:

1. The original Contract Sum.
2. Additions and deductions resulting from:
    a. Previous Change Orders.
    b. Allowances.

END OF SECTION 01 78 00

SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

A. Demonstration of products and systems where indicated in specific specification sections.

B. Training of Owner personnel in operation and maintenance is required for:
   1. All software-operated systems.
   2. HVAC systems and equipment.
   3. Plumbing equipment.
   4. Electrical systems and equipment.
   5. Items specified in individual product Sections.

C. Training of Owner personnel in care, cleaning, maintenance, and repair is required for:
   1. Roofing, waterproofing, and other weather-exposed or moisture protection products.
   2. Finishes, including flooring, wall finishes, ceiling finishes.
   3. Fixtures and fittings.
   4. Items specified in individual product Sections.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Training Plan: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
   1. Submit to Architect for transmittal to Owner.
   2. Submit not less than four weeks prior to start of training.
   3. Revise and resubmit until acceptable.
   4. Provide an overall schedule showing all training sessions.
   5. Include at least the following for each training session:
      a. Identification, date, time, and duration.
      b. Description of products and/or systems to be covered.
      c. Name of firm and person conducting training; include qualifications.
      d. Intended audience, such as job description.
      e. Objectives of training and suggested methods of ensuring adequate training.
      f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
      g. Media to be used, such a slides, hand-outs, etc.
      h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.

C. Training Manuals: Provide training manual for each attendee as designated by the Owner:
   1. Include applicable portion of O&M manuals.
   2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
   3. Provide one extra copy of each training manual to be included with operation and maintenance data.

D. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.
   1. Format: DVD Disc.
   2. Label each disc and container with session identification and date.

1.03 QUALITY ASSURANCE

A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
   1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
   2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

B. Demonstration may be combined with Owner personnel training if applicable.
C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
    1. Perform demonstrations with-in one month after Substantial Completion, unless directed differently by the Owner.
    2. For equipment or systems requiring seasonal operation, perform demonstration for other season within eight months.
D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
    1. Perform demonstrations with-in one month of Substantial Completion, unless directed differently by the Owner.
E. Demonstration and Training Recording: Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
    1. At beginning of each training module, record each chart containing learning objective and lesson outline.
    2. Submit media to Owner with-in two weeks of date the Demonstration and Training occured.

3.02 TRAINING - GENERAL

A. Conduct training on-site unless otherwise indicated.
B. Owner will provide classroom and seating at no cost to Contractor.
C. Provide training in minimum two hour segments.
D. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
E. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
    1. The location of the O&M manuals and procedures for use and preservation; backup copies.
    2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
    3. Typical uses of the O&M manuals.
F. Product- and System-Specific Training:
    1. Review the applicable O&M manuals.
    2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
    3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
    4. Provide hands-on training on all operational modes possible and preventive maintenance.
    5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
    6. Discuss common troubleshooting problems and solutions.
    7. Discuss any peculiarities of equipment installation or operation.
    8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
    9. Review recommended tools and spare parts inventory suggestions of manufacturers.
    10. Review spare parts and tools required to be furnished by Contractor.
    11. Review spare parts suppliers and sources and procurement procedures.
G. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

3.03 DEMONSTRATION

A. Manufacturer’s onsite field technician shall demonstrate the operation of items specified in the specific Technical Sections to the Owner.
    1. A video outlining the operation of the item or system, scheduled maintenance, basic troubleshooting and care of the item or system shall be provided to the Owner by the manufacturer.

END OF SECTION 01 79 00

SECTION 01 91 13
GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Commissioning is intended to achieve the following specific objectives; this section specifies the Contractor's responsibilities for commissioning:
   1. Verify that the work is installed in accordance with Contract Documents and the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup: Startup reports and Prefunctional Checklists executed by Contractor are utilized to achieve this.
   2. Verify and document that functional performance is in accordance with Contract Documents: Functional Tests executed by Contractor and witnessed by the Commissioning Authority are utilized to achieve this.
   3. Verify that operation and maintenance manuals submitted to Owner are complete: Detailed operation and maintenance (O&M) data submittals by Contractor are utilized to achieve this.
   4. Verify that the Owner's operating personnel are adequately trained: Formal training conducted by Contractor is utilized to achieve this.

B. Commissioning, including Functional Tests, O&M documentation review, and training, is to occur after startup and initial checkout and be completed before Substantial Completion.

C. The Commissioning Agent directs and coordinates all commissioning activities; this section describes some but not all of the Commissioning Authority's responsibilities.
   1. The Commissioning Agent is employed by Owner under separate contract for the scope of work in this specification.
   2. The Commissioning agent shall coordinate the scheduling of all commissioning meetings with all team members.
   3. The Commissioning Agent is not responsible for construction means, methods, job safety, or any construction management functions on the job site.

D. Each Contractor shall cooperate and allocate appropriate time to assist in the completion of all commissioning work as described herein including providing all services requiring tools or the use of tools to start-up, test, adjust or otherwise bring equipment and systems into a fully operational state.
   1. The Commissioning Agent shall coordinate and observe these procedures, but shall not perform construction or technician services.
   2. No additional costs will be allowed for required commissioning work.
   3. Systems Operation:
      a. Systems shall be fully operation prior to beginning on-site commissioning testing procedures. The Commissioning Agent shall work directly with the Building Automation System Contractor to receive the sign-off of all self performed functional tests prior to starting on-site testing procedures.

1.02 SCOPE OF COMMISSIONING

A. The following are to be commissioned:

B. Mechanical Systems:
   1. The Commissioning process provides a systematic method to ensure all systems are installed and operating to meet the design intent of the project. The primary focus is the Building Automation System. Building Automation System verification will include point-to-point functional performance testing, sequence of operation testing, and alarm verification. In addition, the following items shall be verified:
      a. The Commissioning process provides a systematic method to ensure all systems are installed and operating to meet the design intent of the project. The primary focus is the Building Automation System. Building Automation System verification will include point-to-point functional performance testing, sequence of operation testing, and alarm verification.
         1) In addition, the following items shall be verified:
            (a) Hydronic System Flush and Fill.
            (b) Test and Balance Verification.

(c) Equipment Start-up Verification.
(d) Systems Training Verification.

2) A successful commissioning outcome requires participation from all of the construction team and sub-contractors, the Owner's Representative, the Architect and Engineer, and Test and Balance Contractor. The Commissioning Agent will conduct regular team meetings starting in construction and continuing through project closeout.
3) Specific requirements of the construction team are delineated within this specification section as well as specific requirements may be noted in other Division 23 sections.
4) The Building Automation System contractor is required to self perform system point-to-point functional tests and provide signed-off checklists as a formal notification that the systems are installed and ready for the Commissioning Agent to begin field testing. Refer to Specification Section 23 09 00 - Building Automation System.

C. Electrical Systems:
1. Emergency power systems.
2. Uninterruptible power systems.
3. Variable frequency drives.
4. Lighting controls other than manual switches.
5. Electronic Safety and Security:
a. Security system, including doors and hardware.
b. Fire and smoke alarms.

D. Communications:
1. Voice and data systems.
2. Public address/paging.

E. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

1.03 DEFINITIONS

A. Commissioning Plan: A document prepared by the Commissioning Agent to clearly communicate the commissioning approach and process to all team members. Elements of the commissioning plan include documentation of all team members and contact information, proposed milestone schedule, allocation of resources, and description of the key elements of the commissioning process.

B. Contractor: A member as designated of the construction team including but not limited to the Construction Manager/Construction Manager at Risk/General Contractor, Mechanical Contractor, Building Automation System Contractor, and/or Electrical Contractor.

C. Commissioning Agent: The designated lead person of the commissioning team.

D. Design Team: The Architect and Engineers responsible for the contract documents.

E. Deficiency Log: An issue tracking form prepared by and maintained by the Commissioning Agent. The log form shall include space for designating responsible parties, sign-offs, dates, and additional comments.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures; except:

B. The Commissioning Agent shall submit the following documents to the Owner's Representative and Design Team as required by this specification section. The schedule for submission of these documents shall be identified within the commissioning plan:
1. Observation Reports:
a. To follow each site visit to document construction progress and identify issues or deficiencies.
2. Commissioning Plan with a detailed milestone schedule to assist in coordinating the participation of all construction team members, Owner's Representative and design team:
a. To be submitted within 60 days of the award of the commissioning contract.
3. Flush and Fill Validation:
a. To be submitted upon completion of the system flush and fill certifying that the procedures were witnessed and are in compliance with the specification requirements.

4. Equipment Start-up Validation:
    a. To be submitted upon completion of all equipment start-up. The intent is that all equipment is started in accordance with Specification requirements. Include factory start-up reports where required.
5. Test and Balance Validation:
6. To be submitted upon review of the certified Test and Balance report prepared by the Test and Balance Contractor.
7. Owner's Training Validation:
    a. To be submitted upon completion of all Owner training. The intent is that all training is completed in accordance with specification requirements.
8. Final Report:
    a. To be submitted upon final closeout of all deficiencies to document all activities through the commission process.

C. Additional submittal requirements for construction team members are noted in other Division 22 and 23 Specification Sections.

1.05 ROLES AND RESPONSIBILITIES

A. All parties involved in the construction process shall be involved in the commissioning process. Following is a description of the responsibilities of each party:

B. Owner/Owner's Representative:
1. Review and Comment on reports and deficiency logs.
2. Attend commissioning meetings.
3. Provide final approval for the successful completion of the commission process.

C. Design Team:
1. Attend commissioning meetings.
2. Resolve interpretations of the design intent and requirements of the contract documents.
3. Provide direction to the design team as required to closeout issues identified on the observation reports and deficiency logs.
4. Review contractor application for payment. Withhold payment as necessary to track construction progress.
5. Review and approve Operation and Maintenance manuals.

D. Commissioning Agent
1. Communicate important milestone schedule dates to the appropriate team members.
2. Coordinate and conduct commissioning team meetings.

E. Construction Team:
1. Implement commissioning tasks identified in this specification section and other Division 22 and 23 specification sections.
2. Include the costs of all commissioning activities in the contract price. No additional costs will be allowed.
3. Provide and document all test procedures required by this and other Specification Sections.
4. Complete corrective actions directed by the Design Team.

F. Test and Balance Contractor:
1. Submit test and balance work plan to include milestone schedule to the Commissioning Agent for review.
2. Provide a preliminary test and balance report prior to substantial completion to verify ventilation air quantities as necessary to obtain the occupancy permit.
3. Assist the Commissioning Agent to verify documentation of the test and balance activities.
4. Provide a final test and balance report.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 MECHANICAL COMMISSIONING DESCRIPTION

A. The purpose of the commissioning process is to provide the Owner assurance that the mechanical systems have been installed and are operating to meet the design intent. The Commissioning Agent shall provide the Owner with an unbiased, objective view of the system's installation, operation, and performance. The Commissioning Agent will coordinate all commissioning activities with the design professionals, construction manager, contractors, subcontractors, manufacturers and equipment suppliers.

B. Commissioning work is a collaborative team effort and will include fine-tuning of control sequences and operational procedures. Commissioning will coordinate system documentation, equipment start-up, control system calibration, testing and balancing, and verification testing.

C. The commissioning team shall be made up of representatives from the owner, design professionals and construction trades. The trades represented on the commissioning team shall include, but not be limited to, sheet metal, piping and fitting, building automation, test and balance, and electrical. The lead person for each trade who will actually perform or supervise the work is to be designated as the representative to the commissioning team. Responsibility for various steps of the commissioning process shall be divided among the members of the commissioning team, as described in this section.

3.02 MECHANICAL/ELECTRICAL COMMISSIONING AGENT WORK SCOPE

A. Construction Phase:

1. Provide commissioning milestone date information to be incorporated into the overall project schedule. Coordinate with the prime mechanical contractor to develop the schedule. Coordinate with the General Contractor or Construction Manager to incorporate in to the overall schedule.
2. Provide a written commissioning plan document to clearly identify the roles and responsibilities of all commissioning team members, specific milestone dates that are incorporated into the overall project schedule, and an outline of the scope of all required field testing. The field testing scope is identified in the Building Acceptance Phase of this specification section.
3. Perform periodic construction site visits concurrent with the installation of the mechanical systems through substantial completion. Provide construction observation reports to identify equipment and system installation deficiencies related to the ability to complete systems testing for the project and for compliance with the plans and specifications.
4. Review submittals (shop drawings) for testability of ventilation equipment, temperature controls, and other water and air flow control devices.
5. Coordinate and conduct regular commissioning team meetings to clearly develop an understanding of the roles and expectations of all construction team members. Identifying deviations from the construction schedule as it relates to completing site testing and developing a plan as necessary to get the project on schedule shall be a primary focus of the meeting. Meetings shall occur weekly during construction leading up to substantial completion and continue at a minimum bi-weekly until all project issues are closed out.
6. Coordinate and direct the system-inspection activities in a logical, sequential, and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, and frequently updated timelines and schedules and technical expertise.
7. Provide project-specific pre-functional tests and checklists. Checklists shall be distributed to the Building Automation Contractor early in the construction process to set the expectation for testing. Gather and review the current control sequences to include the approved control submittals and subsequent construction changes. Coordinate with the contractors and the design engineer to resolve any discrepancies.
8. Develop and implement equipment specific start-up test procedures to validate major equipment start-up by contractors. Verify checklists and witness start-up of equipment.
9. Witness the hydronic system flushing procedures performed by the contractor and provide a report of all activities to demonstrate compliance with the specification requirements.
10. Coordinate and lead a test and balance kick-off meeting to include the Test and Balance Contractor, Building Automation System Contractor, and the Mechanical Contractor prior to the commencement of preliminary system balancing to establish quality expectations.

B. Building Acceptance Phase:
   1. Perform HVAC system functional performance testing through the front end controls interface. It is the intent of the functional performance testing to verify that the system components are wired and mapped correctly in the automation system and that the controlled components act as commanded through their full range of motion. Coordinate with the Building Automation System contractor for access to building automation system necessary to perform testing. Provide staff as necessary to witness functional tests on devices concurrent with responses on the front-end interface. The extent of the functional performance testing is defined by specification section . Testing shall include:

C. 100% point to point verification of all HVAC component operations.
   1. Perform HVAC system sequence testing through the front end controls interface. It is the intent of the sequence testing to verify that the system components are controlled to accomplish the intent of the control sequences as written in specification section 23 09 00 - Building Automation System. Coordinate with the Building Automation System Contractor for access to building automation system necessary to perform testing. Provide staff as necessary to witness sequence tests on devices concurrent with responses on the front-end interface. The extent of sequence testing is defined by specification section 23 09 00 - Building Automation System. Testing shall include:
      a. 100% verification of system sequences of control
      b. 100% alarm verification
      c. 100% graphic representation accuracy.
   2. At the conclusion of each scheduled testing session, provide a corrective action report to the construction team. The corrective action report shall be a running log of all corrective action items to document deficiencies and to track correction progress.
   3. Perform follow-up inspections as necessary to verify that corrective action items are complete. Requests for additional fees for testing will not be accepted.
   4. Conduct regular Commissioning Team meetings through conclusion of all testing to review the deficiency log and set schedule expectations on the Contractor.
   5. All seasonally dependent system and control operations shall be tested in the appropriate season as weather permits. The testing schedule will be coordinated based on the project needs.
   6. Coordinate and oversee the work of the Test and Balance contractor. Review the Test & Balance report for accuracy and spot check report values in the field. Verification of ventilation air flows shall include verification that air flow stations are calibrated and reading within expected tolerance range.

D. Building Turnover/Occupancy Phase:
   1. Review the Operations and Maintenance manuals for both projects for accuracy and completeness. Provide comments to the Owner and project team.
   2. Review all as-built drawings for the projects for accuracy and completeness. Provide comments to the Owner and project team.
   3. Develop and submit a final Commissioning Report including a summary of the commissioning scope, a copy of all generated documentation and associated correspondence, and a copy of all field-testing results. The final commissioning report shall be delivered no later than one year after substantial completion.
   4. Document that all training of owner personnel as required by the specification has been provided.
   5. Attend the 11-month walk-thru sessions for both projects as directed by the project team, and provide comments to the Owner and project team.

E. Mechanical Systems To Be Commissioned:
   1. It is the intent that the full extent of the building automation system be tested. Refer to specification section 23 09 93 - BAS Sequence of Operations.
   2. At a minimum, the following pieces of mechanical equipment and systems shall be commissioned:
      a. Air handling systems, including air distribution and exhaust systems.
      b. Heating plant and hot water distribution systems.
      c. Chilled water plant and distribution systems.
      d. DX cooling systems
      e. Electric heating systems
      f. Domestic hot water systems

F. Electrical Systems To Be Commissioned:
   1. At a minimum, the following pieces of electrical equipment and systems shall be commissioned:
      a. Emergency generator.
      b. Lighting control systems.

3.03 COMMISSIONING - CONSTRUCTION TEAM WORK SCOPE

A. Commissioning Team:
   1. The General Contractor/Construction Manager/Construction Manager at Risk and each contractor shall designate a single individual as the primary contact for all commissioning activities.
B. Construction Schedule:
   1. The overall construction schedule and scheduling the work of all trades is the responsibility of the construction team. The commissioning process does not relieve any contractors from their obligation to complete all portions of work in a satisfactory manner.
C. Commissioning Team Meetings:
   1. Commissioning team meetings will be scheduled regularly starting in construction and continuing through project closeout. Meetings should be anticipated to be weekly. Costs to cover meeting activities shall be included in the Contractor's bid. Attendance at meetings is mandatory for all contractors with open issues.
D. Submittal Review:
   1. The Commissioning Agent will be copied on all submittals reviewed by the Design Team. Submittals shall include the manufacturer's recommended start-up procedures or testing checklist. In addition, any equipment provided with factory packaged stand-alone controllers shall be provided with written control sequences and documentation of the controller point list.
   2. The Building Automation System submittal shall be copied to the Commissioning Agent for preliminary review and comment upon the initial distribution to the Design Team. The Commissioning Agent will provide comments to the Design Team to consolidate comments prior to returning to the Contractor. The final reviewed submittal will be used by the Commissioning Agent to develop checklists and testing procedures.
E. Observation Reports:
   1. The Commissioning Agent will perform periodic site inspections to review the installation for compliance with the construction documents and for specific features related to testability of ht systems. Site observation reports will be prepared and distributed to all Commissioning Team members. The Design Team will resolve any disputes related to the scope of intent of the construction drawings.
F. Construction Checklists:
   1. Will be developed and distributed by the Commissioning Agent to the Construction Team. The checklists contain criteria for accepting the equipment related to delivery, installation, and start-up.
   2. Shall be completed by the installing contractor verifying that the installation is complete in conformance to the requirements of the construction documents and the manufacturer's installation guidelines. Checklists shall be completed and reviewed prior to start-up.
G. Air and Balance Verification
   1. Provide a preliminary Test and Balance report to the Commissioning Agent for review prior to Substantial Completion of the project. The report shall include draft forms and Test and Balance procedures, the preliminary report shall include documentation of ventilation air flows as may be required for the occupancy permit.
   2. The final Test and Balance report will be reviewed for completeness and accuracy by the Commissioning Agent.
   3. The Test and Balance Contractor shall provide a field technician to work with the Commissioning Agent to verify accuracy and measurements documented in the Test and Balance report. Refer to paragraph B of this section for the scope of the verification process.

H. Functional Performance Testing
   1. On-site testing will be scheduled by the Commissioning Agent upon notification that the systems are fully operational and ready for testing. Notification by the Construction Team to the Commissioning Agent shall include the following:
      a. Construction checklists (including as required factory start-up reports).
      b. Preliminary Test and Balance Report.
      c. The Building Automation System Contractor shall return all required self performed functional test checklists as required in Part 3 of Specification Section 23 09 00 - Building Automation System.
      d. Manufacturer's written test report on electrical systems that they have been tested, approved and commissioned by the manufacturer for the following systems:
         1) Emergency generator.
         2) Lighting control systems.
   2. The Construction Team shall assist the Commissioning Agent to test the building systems in all modes of operation to ensure the components, systems and facility operate as intended for building turnover. Testing by the Commissioning Agent will include a minimum the following:
      a. Functional Performance Verification:
         1) 100% verification of all physical control points including sensor calibration and status, and output verifications. These tests shall be performed by physically measuring the condition at the sensor, observing the device state, or verifying the device action, and comparing to the value or command on the automation system graphic.
      b. Alarm Verifications:
         1) Alarm devices should be tripped, and verifying the appropriate alarm is displayed on the graphic and/or sent out as specified.
      c. Graphics Review:
         1) Verify that the automation system graphics accurately depict the actual equipment or systems, and are navigable as specified. This includes, but is not limited to: sensor or device locations on an equipment graphic matches the actual location, graphic floorplans are navigable as specified, trends and schedules are accessible, and links operate properly.
      d. Sequence Verifications:
         1) After proving the automation system points during point to point verifications, all control sequences included in the construction documents will be verified. Sequence testing will include normal operating mode and any emergency failure or standby power sequences.
      e. Integrated System Tests:
         1) Perform tests to ensure that pieces of individual equipment operate together in a system properly, and the systems operate with other systems together as a whole.
   3. The Commissioning Agent will develop and witness all testing procedures. The Contractor will be required to assist in functional testing, including, but not limited to: providing access to equipment and components, the use of ladders, lifts, scaffolding and platforms, removal of access panels, opening of equipment, manipulation or operation of equipment or components, etc.
      a. After the Commissioning Agent has reviewed and accepted contractor checkout documents, Commissioning Agent witness testing will be coordinated between the Commissioning Agent and the appropriate contractors.
      b. The Contractor shall assist the Commissioning Agent with all functional testing, as required by the Commissioning Agent.
      c. The Contractor shall provide necessary setpoints on all monitor screens so that all sequences of operation can be functionally tested or assist with all sequence testing that cannot be performed with current monitor screen setpoints.
      d. The Contractor shall provide the Commissioning Agent proper system access ability to fully test the system. This includes appropriate logins and passwords.

4. Testing Failures:
    a. The Contractor may be allowed to correct & retest minor deficiencies immediately at the discretion of the Commissioning Agent. However, the Commissioning Agent reserves the right to document a failure on the deficiency list and move on to other testing if the issue will take longer than 5 minutes to correct, or if excessive failures are discovered.
    b. If 10%, or 3 instances, whichever is greater, of similar deficiencies are encountered during any portion of the commissioning process, the Commissioning Agent reserves the right to cease further testing or inspections of that particular item and identify the issue as a failure typical of all. The contractor will be responsible for re-verifying 100% of the items before the Commissioning Agent continues testing/inspecting that issue.
    c. The Commissioning Agent will not provide direction to Contractors to make changes to any systems. The Contractor can choose to take responsibility for an item and make corrective actions at their discretion. If the contractor disagrees, or believes that a documented issue is beyond their contracted scope of work, they may respond in writing to the Design Team for review.
    d. A rolling deficiency log will be developed and issued to the Owner and Design Team for appropriate action.
    e. The Commissioning Agent will retest deficiencies one time when notified in writing by the appropriate Contractor that corrective actions were taken. The Contractor shall meet on site with the Commissioning Agent to verify the items noted on the deficiency log are complete.
        1) The Commissioning Agent will notify the Design Team, Owner and Contractor of retesting required by issuing an Additional Services Notification.
            (a) If additional Commissioning Agent testing is required, a deduct change order will be processed to the Contractor(s) to cover the additional testing incurred by the Owner, from the Commissioning Agent.
    f. Seasonal testing may be required if ambient weather conditions do not allow for reasonable testing conditions during the initial functional testing phase to place heating or cooling systems under full load.
    g. It is the Contractor's responsibility to ensure that all system, equipment and component warranties remain in place throughout the startup, commissioning, and training process. The Contractor or Supplier will notify the Owner's Representative in writing if the proposed commissioning activities endanger warranties.
    h. The Contractor shall be responsible for maintaining the Project Record Documents as outlined elsewhere in the contract documents. The Contractor shall record adjustments, changes, and clarifications made during the startup, commissioning and training processes.

I. Training Coordination:
1. The Commissioning Agent will assist the Construction Team to organize and coordinate training. Training is the responsibility of the Construction Team including scheduling factory authorized personnel where required. The Commissioning Agent will work with the Contractors to ensure training is complete and meets the needs of the Owner.
    a. Refer to Section 01 79 00 - Demonstration and Training.
2. The Construction Team shall provide an instructional program to the Commissioning Agent for review prior to the start of training. The program shall include the following:
    a. List of each building component and equipment for which the Owner is to receive training.
    b. Proposed schedule including dates and times. The specific planned duration shall be noted.
    c. Instructors name and contact information.
    d. Recommended names and Owner' group required for attendance.
3. The Construction Team shall maintain an attendance record and submit to the Commissioning Agent upon completion of all training.

3.04 FIELD TESTING AND COMMISSIONING OF PARTITIONS FOR NOISE ISOLATION

A. Commissioning Agent Responsibilities:
   1. Conduct testing of partitions requiring a specific STC class indicated on drawings and/or in various specifications sections. Comply with ASTM E336 for testing methods, including requirements of Annex A1 for reduction of flanking sound transmission.
   2. Confirm that the FSTC values are not less than 67 percent of design STC values.
   3. Re-test deficiencies after correction by the Contractor.

B. Contractor(s) Responsibilities:
   1. Correct deficiencies and notify the Commissioning Agent when complete and ready for re-testing.
      a. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.
      b. Sealants for remedying flanking sound transmission deficiencies evidenced as excessive air leakage are specified in Section 09 21 16 - Gypsum Wallboard Assemblies.

END OF SECTION 01 91 13

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Selective demolition of building elements for alteration purposes.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Schedule indicating proposed sequence of operations for selective demolition work to Owner's Representative/Construction Manager for review prior to start of work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control.

C. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.

1. Coordinating with the Owner’s continuing occupation of portions of existing building and with Owner’s partial occupancy of completed new construction areas.

1.03 SELECTIVE DEMOLITION JOB CONDITIONS

A. Occupancy: Owner will occupy portions of the building immediately adjacent to areas of selective demolition. Conduct selective demolition work in manner that will minimize need for disruption of Owner’s normal operations. Provide minimum of 72 hours advance notice to Owner’s Representative of demolition activities that will affect Owner’s normal operations.

B. Condition of Structures: Owner assumes no responsibility for actual condition of items or structures to be demolished.

1. Conditions existing at time of inspection for bidding purposes will be maintained by Owner insofar as practicable. However, minor variations within structure may occur by Owner's removal and salvage operations prior to start of selective demolition work.

C. Partial Demolition and Removal: Items indicated to be removed but of salvageable value to Contractor may be removed from structure as work progresses. Transport salvaged items from site as they are removed.

1. Storage or sale of removed items on site will not be permitted.

D. Protection: Provide temporary barricades and other forms of protection to protect Owner’s personnel, students and general public from injury due to selective demolition work.

1. Coordinate protective measures with those to be performed or constructed for asbestos abatement work. Avoid duplication of work where practical.
2. Provide protective measures as required to provide free and safe passage of Owner’s personnel and general public to occupied portions of building.
3. Erect temporary covered passageways as required by authorities having jurisdiction.
4. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain.
5. Protect from damage existing finish work that is to remain in place and which becomes exposed during demolition operations.
6. Protect floors with suitable coverings when necessary.
7. Construct temporary insulated dustproof partitions where required to separate areas where noisy, dirty or dusty operations are performed. Construct partitions out of metal stud, poly and gypsum board and provide dustproof doors and security locks.
8. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.

E. Damages: Promptly repair damages caused to adjacent facilities by demolition work.

F. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

1. Do not close, block, or otherwise obstruct streets, walks, or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

G. Flame Cutting: Do not use cutting torches for removal until work area is cleared of flammable materials. At concealed spaces, flame cutting will not be allowed. Maintain portable fire suppression devices during flame-cutting operations.

H. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.
   1. Do not interrupt utilities serving occupied or used facilities or spaces, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner.
   2. Maintain fire protection services during selective demolition operations.
   3. Maintain HVAC functions in occupied spaces, in so far as possible. Provide temporary heating and ventilation as required to maintain acceptable working conditions. Do not interrupt functions to occupied spaces, except as shown on the demolition plans or when authorized in writing by the Owner.

I. Environmental Controls: Use temporary enclosures, and other methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection.
   1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution, or damage to finishes or occupied spaces.

J. Do not use highly odoriferous, hazardous or highly volatile chemicals during demolition without the approval of the Owner. Provide appropriate safeguards during the use of such approved materials.

K. Lead Containing Materials: The existing building may contain lead-containing materials, including lead paint. It is the Contractor's responsibility to meet all governmental regulations when dealing with and disposing of lead containing materials.

1.04 QUALITY ASSURANCE

A. Demolition Firm Qualifications: Company specializing in the type of work required, of similar size of project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before starting demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Pre-demolition Conference: Conduct conference at project site to comply with pre-installation conference requirements of Division 1.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 DEMOLITION

A. Remove the portions as noted on the drawings.
   1. Demolish and remove slabs, steel framing, CMU and Brick at canopy, plaster and drywall partitions, flooring, brick flooring, ceilings, canopy roof structure, roof spire, fixed equipment and casework, doors, windows, roofing, electrical and mechanical equipment.
   2. Removal and legal disposal of all PCB-containing light fixture ballasts and other miscellaneous PCB-containing equipment.
   3. Removal and legal disposal of all light bulbs, thermostats, batteries and other items containing mercury, lead or cadmium.
   4. Removal, stabilization and legal disposal of all peeling and flaking lead-based paint.
   5. Removal and legal disposal of items that may contain oil, R-22 refrigerant, hydraulic oil, boiler chemicals, fire extinguishing agents, and ammonia.

B. Selective removal of portions of existing building indicated on drawings and as required, to be removed and disposed of off site, to accommodate new construction.
   1. Removal and protection of existing fixtures, materials, and equipment items indicated “salvage.”

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.

3. Provide, erect, and maintain temporary barriers and security devices.
4. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
5. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
6. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
7. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
8. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
9. Provide for effective air and water pollution controls as required by local authorities having jurisdiction.

B. Cover and protect furniture, equipment, and fixtures from soilage or damage when demolition work is performed in areas where such items have not been removed.

C. Do not begin removal until receipt of notification to proceed from Owner, the Owner's Designated Representative or the Construction Manager.

D. Do not begin removal until built elements to be salvaged or relocated have been removed.

E. Do not begin removal until vegetation to be relocated has been removed and vegetation to remain has been protected from damage.

F. Protect existing structures and other elements to remain in place and not removed.
1. Provide bracing and shoring.
2. Prevent movement or settlement of adjacent structures.
3. Stop work immediately if adjacent structures appear to be in danger.

G. Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

H. If hazardous materials are discovered during removal operations, stop work and notify General Contractor or Construction Manager and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury. Follow the following procedures:
1. If the materials are not disturbed, stop work in the immediate area and notify the Owner/Construction Manager who will arrange for abatement of the material.
2. If the material has been disturbed by demolition operation, or is otherwise loose or damaged, evacuate the immediate area and restrict access to all personnel. Shut off or isolate HVAC to the area. Notify the Owner/Construction Manager and do not re-enter space until abatement is complete and permission has been received.
3. Rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.

I. Locate, identify, stub off, and disconnect utility services that are not indicated to remain.
1. Provide bypass connections as necessary to maintain continuity of service to occupied areas of building. Provide minimum of 72 hours advance notice to Owner if shutdown of service is necessary during changeover.

J. Perform demolition in a manner that maximizes salvage and recycling of materials.
1. Dismantle existing construction and separate materials.
2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

3.03 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
1. Verify construction and utility arrangements are as indicated.
2. Report discrepancies to General Contractor or Construction Manager before disturbing existing installation.
3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

B. Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.
C. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools.
D. For interior slabs on grade, use removal methods that will not crack or structurally disturb adjacent slabs or partitions. Use power saw where possible.
E. Prior to any floor slab cutting and removal, contractor to identify any and all underground mechanical and electrical items by means such as, but not limited to: X-ray, ground penetrating radar, tracing, etc. Any damage will be replaced at expense of Contractor. Contractor must give General Contractor or Construction Manager 48 hour notice prior to any floor slab cutting.
F. Separate areas in which demolition is being conducted from areas that remain occupied.
    1. Erect and maintain dust-proof partitions and closures as required to prevent spread of dust or fumes to occupied portions of the building.
        a. Where selective demolition occurs immediately adjacent to occupied portions of the building, construct dust-proof partitions of minimum 3-5/8" metal studs, 5/8-inch drywall (joints taped) on occupied side, 1/2-inch fire-retardant plywood on demolition side. Fill partition cavity with insulation. Provide lockable dustproof doors.
        b. Provide similar weatherproof closures for exterior openings resulting from or immediately adjacent to demolition work.
G. Remove existing work as indicated and required to accomplish new work.
    1. Carefully remove, clean and salvage items indicated on drawings.
        a. Furniture/building contents, not scheduled for reuse, remain property of Owner. Notify Architect if such items are encountered and obtain approval regarding method of removal and salvage for the Owner.
        b. Store salvaged items to be reused off the ground in a clean, dry location, away from uncured concrete or masonry. Cover with waterproof material in a manner that permits air circulation within covering.
        c. For items to be reused, inventory, label with previous location and new location.
    2. Leave all surfaces and work ready and acceptable to the next trade. Use only materials and techniques that are acceptable to subsequent trades to remove materials from surfaces to remain.
        a. Remove adhesive and other materials where wall and floor coverings are removed.
    3. Patch or repair demolition in excess of that shown on drawings.
H. If unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to General Contractor or Construction Manager in written, accurate detail. Pending receipt of directive from Architect, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.
    1. Cease operations and notify Architect, General Contractor or Construction Manager immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.
I. Protect existing work to remain.
    1. Prevent movement of structure. Provide shoring and bracing as required.
    2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
    3. Repair adjacent construction and finishes damaged during removal work.
        a. Patch to match new work.

3.04 DEBRIS, WASTE REMOVAL AND CLEANUP

A. Remove debris, junk, and trash from site.

B. Remove and legally dispose of off site, all materials not to be reused on site; do not burn or bury.

1. Disposal of all PCB-containing light fixture ballasts and other miscellaneous PCB-containing equipment, items containing mercury, lead or cadmium, oil, R-22 refrigerant, hydraulic oil, boiler chemicals, fire extinguishing agents and ammonia is the responsibility of the Contractor. The Contractor shall carefully remove all such equipment and place it in containers and deliver to a certified hazardous waste disposal service and/or a certified hazardous lamp recycling service. The Contractor shall provide the Owner with certified documentation that these items have been legally disposed of.

C. Remove protection when no longer required by demolition and remodeling work.

D. Leave site in broom clean condition, ready for subsequent work.

E. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 02 41 00

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Details of Construction, and General Provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

A. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.
B. Openings for other work.
C. Form accessories.
D. Form stripping.

1.03 RELATED REQUIREMENTS

A. Section 01 45 33 - Structural Testing and Special Inspection.
B. Section 03 20 00 - Concrete Reinforcing.
C. Section 03 30 00 - Cast-in-Place Concrete.
D. Section 05 12 00 - Structural Steel Framing: Placement of embedded steel anchors and plates in cast-in-place concrete.

1.04 REFERENCE STANDARDS

A. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).
B. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
C. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
D. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).

1.05 DESIGN REQUIREMENTS

A. Design, engineer and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.06 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI PRC-347, ACI SPEC-301, and ACI 318.

PART 2 PRODUCTS

2.01 FORMWORK - GENERAL

A. Provide concrete forms, accessories, shoring, and bracing to accomplish cast-in-place concrete work.
B. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
C. Chamfer exposed outside corners of beams, joists, columns, and walls 3/4".
D. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
E. Comply with relevant portions of ACI SPEC-301.

2.02 FORM MATERIALS

A. Form Materials: At the discretion of the Contractor.

2.03 FORMWORK ACCESSORIES

A. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
B. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 05 12 00.

PART 3 EXECUTION

3.01 EXAMINATION

A. Establish a bench mark in an accessible location and use as a reference point for various construction levels. Maintain in an undisturbed condition until final completion.
B. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

A. Earth forms are not permitted.

3.03 ERECTION - FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI SPEC-301.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Lay out all work and check general building lines and levels established. Coordinate layout and measurements and if discrepancies arise, report them to the Architect.

D. Keep wood forms wet as necessary to prevent shrinkage.

E. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

F. Align joints and make watertight. Keep form joints to a minimum.

G. Obtain approval before framing openings in structural members that are not indicated on drawings.

H. Coordinate this section with other sections of work that require attachment of components to formwork.

I. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect before proceeding.

J. Protect work at all times against the elements and other hazards. Cover and secure work.

3.04 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in passing through concrete work.

B. Locate and set in place items that will be cast directly into concrete.

C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.

D. Place and secure anchor rods and structural steel embeds before concrete is placed. “Wet sticking” of these elements is not permitted.

E. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.

3.06 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
2. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.07 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI SPEC-117. See section 03 30 00 for additional requirements.

1. Provide Class B surface for exposed concrete.
2. Provide Class C or Class D surface for concealed concrete.

B. Tolerances given in ACI SPEC-117 are not cumulative. Maximum tolerance for any formed surface, except footings, shall be one inch.

3.08 FIELD QUALITY CONTROL

A. Structural Special Inspection

1. Structural Special Inspection shall be performed by qualified parties as specified herein, and in accordance with the provision of Section 01 45 33.
2. Formwork for slabs on grade, strip footings without transverse reinforcement, isolated spread footings, and topping slabs does not require inspection. Additional exceptions may be noted on the structural drawings.
3. Personnel Qualifications: Special Inspector – Structural I: ICC certified concrete inspector or a graduate civil/structural engineer, or other personnel acceptable to the Structural Engineer of Record (SER), with the experience in the design of structural systems of this type. Inspections shall be performed under the direct supervision of a licensed structural engineer, as defined in Section 01 45 33. The licensed engineer shall review and approve all inspection reports.
4. The Owner will provide the following inspections:
    a. Verify formwork for all concrete, except as noted above, will result in member size, location, and configuration as described on the contract documents, only as it affects the structural integrity of the concrete elements to be placed. Verify removal of shoring conforms to this section. Qualifications: Structural I.
    b. Verify placement of anchor rods and other embedments supporting structural steel for compliance with the construction documents. At a minimum, the diameter, grade, type and length of the anchor rod or embedded item, and the extent or depth of embedment into the concrete, shall be verified and documented prior to placement of concrete. Qualifications: Structural I.

3.09 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

B. Forms for sides of columns and footings shall remain in place for a minimum of 24 hours.

C. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

D. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

END OF SECTION 03 10 00

SECTION 03 15 10
POST-INSTALLED ANCHORS

PART 1 GENERAL

1.01 CONTRACT CONDITIONS

A. Drawings, Details of Construction, and General Provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

A. Requirements pertaining to post-installed anchors for materials and equipment. This section pertains to Divisions 3, 5, and 6 of these specifications that require post-installed anchors, unless specified otherwise.

1.03 RELATED REQUIREMENTS

A. Division 1 – General Requirements
B. Division 3 – Concrete
C. Division 5 – Metals
D. Division 6 - Wood, Plastics, and Composites

1.04 REFERENCES

A. ACI 318-14 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
C. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement; 2022a.
D. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
E. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel; 2021.
F. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.
G. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.
H. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
I. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.

1.05 QUALITY ASSURANCE

A. Post-Installed anchors and related materials shall be listed by one or more of the following agencies, as applicable:
    1. ICC Evaluation Service
    2. Underwriters Laboratories (UL) and/or Factory Mutual (FM)
    3. IAPMO Evaluation Service

1.06 SUBMITTALS

A. Product Data: Submit data for proprietary materials, manufacturer’s specifications (including finishes and/or materials), Material Safety Data Sheets (MSDS) and installation procedures.
B. Test Reports: ICC-ES or IAPMO-UES listings.

1.07 SUBSTITUTIONS

A. Only manufacturers with an ICC-ES or IAPMO listing will be considered for substitution requests.
B. The contractor shall submit for Engineer-of-Record’s review, calculations that are prepared & sealed by a Professional Engineer licensed in the State in which the Project is located demonstrating that the substituted product is capable of achieving the pertinent equivalent performance values of the specified product using the appropriate design procedure and/or standard(s) in compliance with the governing Building Code. In addition, the calculations shall specify the diameter and embedment depth of the substituted product.
C. Any increase in material costs for such submittal shall be the responsibility of the contractor.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive Anchors
   1. Adhesive anchors consist of an insert and an adhesive.
   2. Inserts
      a. Threaded Rod Inserts: Provide preparation or configuration as recommended by manufacturer.
         1) Interior Exposure: ASTM F1554.
      b. Reinforcing Bar Inserts: ASTM A615/A615M or ASTM A706/A706M. Provide preparation or configuration as recommended by manufacturer.
   3. Adhesives for Concrete:
      a. Evaluation report issued by ICC-ES or IAPMO required.
      b. Tested and qualified for use in cracked and uncracked concrete in accordance with ICC-ES AC308 for all mandatory and optional seismic tests including creep tests.
      c. Epoxy: ASTM C881/C881M Type IV, Grade 3, Class B and C.
         1) Acceptable products include:
            (a) Simpson Strong-Tie: SET-3G (ICC-ES ESR-4057).
            (b) Hilti: HIT-RE 500 V3 (ICC-ES ESR-3814).
            (c) DeWalt: PURE220+ (ICC-ES ESR-5144).
      d. Acrylic: Cartridge type, two-component, acrylic based system dispensed and mixed through a static mixing nozzle supplied by the manufacturer. Minimum physical requirements of ASTM C881/C881M Type IV, Grade 3, Class A, B and C.
         1) Acceptable products include:
            (a) Hilti: HIT-HY 200 V3 (ICC-ES ESR-4868).
            (b) DeWalt: AC200+ (ICC-ES ESR-4027).
            (c) Simpson Strong-Tie: AT-3G (ICC-ES ESR-5026).

B. Concrete and Masonry Screw Anchors
   1. Concrete Screw Anchors:
      a. Carbon steel heat-treated or hardened.
      b. Zinc-plated in accordance with ASTM B633, Class SC1, Type I or equivalent coating.
      c. Mechanically galvanized (where noted): ASTM B695, Class 55, Type 1.
      d. Evaluation report issued by ICC-ES or IAPMO required.
      e. Tested and qualified for use per ICC-ES AC193 for all mandatory tests .
      f. Acceptable products include:
         1) Simpson Strong-Tie: Titen HD (ICC-ES ESR-2713).
         2) Hilti: Kwik HUS-EZ (ICC-ES ESR 3027).
         3) DeWalt: Screw-Bolt+ (ICC-ES ESR-3889).

PART 3 EXECUTION

3.01 INSTALLATION

A. Install anchors in strict accordance with manufacturer's printed instructions and, where required, requirements of ICC-ES evaluation reports.

B. Conform to manufacturer's requirements for, but not limited to, hole drilling methods, hole size, hole cleaning, substrate and adhesive temperatures, moisture presence in holes, and required edge distance and spacing. Unless noted otherwise, dry holes are required.

C. Use special tools when recommended by manufacturer for installation of anchors unless otherwise permitted specifically by the Engineer or Architect of Record.

D. Drill holes in concrete, in accordance with the manufacturer’s recommendations.

3.02 FIELD QUALITY CONTROL

A. Manufacturer shall, on request, provide the services of a field representative to demonstrate to and train installers in proper installation techniques.

B. Structural Testing and Special Inspection

1. Structural Special Inspection shall be performed by qualified parties as specified herein, and in accordance with the provision of Section 01 45 33.
2. Special Inspection, periodic or continuous, of post-installed anchors shall be provided as specified herein, but not less than as required by ICC-ES evaluation reports.
3. Definitions: ASNT - American Society for Non-Destructive Testing
4. Personnel Qualifications
    a. Special Inspector Technical I: ASNT Level I, employed by a testing agency and supervised by an ASNT Level III with a minimum of 10 years experience.
    b. Special Inspector Technical II: ASNT Level II, employed by a testing agency and supervised by an ASNT Level III with a minimum of 10 years experience.
    c. Special Inspector – Structural I: Graduate civil/structural engineer, or other personnel acceptable to the SER, with experience in design of structural systems of the project type. Inspections shall be performed under the direct supervision of a licensed structural engineer, as defined in Section 01 45 33. The licensed engineer shall review and approve all inspection reports.
5. The Owner will provide the following tests and inspections:
    a. Continuous special inspection during installation to verify materials delivered to site comply with contract documents, bolt type and dimensions, concrete type and compressive strength, pre-drilled hole dimensions and cleaning, embedment, spacing, edge distances, slab thickness, tightening torque, and any other items requiring inspection by product's ICC approval report. Qualifications: Technical II or Structural I.

END OF SECTION 03 15 10

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Details of Construction, and General Provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

A. Reinforcing steel for cast-in-place concrete.
B. Reinforcing steel for masonry.
C. Supports and accessories for steel reinforcement.

1.03 RELATED REQUIREMENTS

A. Section 01 45 33 - Structural Testing and Special Inspection.
B. Section 03 10 00 - Concrete Forming and Accessories.
C. Section 03 15 10 - Post-Installed Anchors.
D. Section 03 30 00 - Cast-in-Place Concrete.

1.04 REFERENCE STANDARDS

A. ACI PRC-315 - Guide to Presenting Reinforcing Steel Design Details; 2018
B. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
C. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
D. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
E. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
F. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2022.
G. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars; 2021.
H. CRSI (DA4) - Manual of Standard Practice; 2024.
I. CRSI (P1) - Placing Reinforcing Bars, 10th Edition; 2019.

1.05 SUBMITTALS

A. See Division 1 for submittal procedures.
B. Shop Drawings: Follow recommended practices of ACI PRC-315. Include size, length, bar schedules, shapes of bent bars, spacing of bars, methods of supporting reinforcing, and location and length of splices. Provide details necessary to show final position of reinforcement in elements.
    1. Include shop drawings for masonry reinforcing
    2. If shop drawings are resubmitted after the original review, identify all changes made to the shop drawings after the original submittal with clouds or similar markings.

1.06 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI SPEC-301 and ACI 318.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver all reinforcement to the Project site bundled, tagged, and marked.
B. Store all reinforcing steel bars, ties, wire fabric, etc., on the site in a manner that will permit access for proper inspection and identification.
C. Do not exceed design capacity of existing construction or formwork.
D. Store reinforcing to avoid contact with mud, grease, or other materials that would affect bond.
E. Special handling for epoxy coated reinforcing to include:
    1. Support epoxy-coated bars or bundles of bars to prevent damage to coating during transit.
    2. Store epoxy-coated bars on protective cribbing.
    3. Lift bundles of epoxy-coated bars at multiple pickup points to minimize bar-to-bar abrasion due to sags in the bundles.

4. Do not drop or drag epoxy-coated bars or bundles of bars.
5. Provide padded contact areas on equipment used for handling epoxy-coated bars.

PART 2 PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
   1. Deformed billet-steel bars.
   2. Unfinished.
   3. Epoxy coated in accordance with ASTM A775/A775M where noted.

B. Reinforcement Accessories:
   1. Chairs, Bolsters, Bar Supports, Spacers: CRSI MSP-1 Chapter 3. Sized and shaped for adequate support of reinforcement during concrete placement.
      a. Class 1 for all surfaces exposed to weather.
      b. Class 1 or 2 for interior surfaces exposed to view.
      c. Class 3 for surfaces not exposed to view.
   2. Bar Supports and Accessories for epoxy coated bars: CRSI MSP-1 Chapter 3, Class 1A epoxy, vinyl, or plastic coated, all plastic supports, or precast supports with epoxy or plastic coated wire.
      a. Use epoxy-coated reinforcing bars as support bars.
      b. Fasten epoxy-coated reinforcing bars to bar supports, accessories, and each other with nylon, epoxy or plastic coated tie wire.
   3. Patching Materials for Epoxy Coated Bars: ASTM D3963/D3963M Annex A1, inert in concrete.
   4. Mechanical couplers: Develop 125% of yield strength, ICBO approved. Dayton/Richmond: Barlock Coupler System, Erico: Lenton Couplers, or approved equal.
   5. Post-installed reinforcing adhesive: See section 03 15 10.

2.02 DETAILING

A. Detail reinforcing steel in accordance with ACI PRC-315 and ACI 318.

B. Splice reinforcing where indicated on drawings. Specifically note proposed splices not shown on the drawings on the shop drawings and highlight for reviewer's acceptance.

C. Provide epoxy coated reinforcing for all concrete exposed to weather such as exterior walls, slabs, columns, piers, landings, stoop slabs, loading docks, and stairs. Additional locations may be noted on the drawings. Building foundation walls do not require epoxy coated reinforcing unless shown on the drawings.

D. Provide bar supports and other accessories sufficient to maintain reinforcing within specified placing tolerances. Consider requirements of CRSI MSP-1 to be a minimum.

E. Provide bar supports for all reinforcing, including footings, slabs on grade, grade beams, and slab temperature reinforcing.

F. Consider normal construction activities while detailing number and type of bar supports.

G. Detail reinforcing to accommodate forming, fabricating, and placing tolerances and maintain a minimum cover as specified.

2.03 FABRICATION

A. Fabricate concrete reinforcing in accordance with ACI 318 and ACI SPEC-301.

B. Fabricate within tolerances given in ACI SPEC-117.

C. Welding of reinforcement is not permitted.

D. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.

PART 3 EXECUTION

3.01 PREPARATION - PLAIN BARS

A. Clean all reinforcement before placing. Remove oil, mill scale, pitting, mud, loose rust, strong alkali or organic matter.

B. Remove all excessive rust with wire brush or by sandblasting.

C. Reinforcement with rust and/or mill scale shall be acceptable if a hand-brushed test specimen meets the applicable ASTM requirements for dimension, weight, and height of deformations.

3.02 PREPARATION - EPOXY COATED BARS

A. Repair coating damage larger than 0.1 square inch in accordance with patching material manufacturer's recommendations.

B. Remove oil, mud, strong alkali, or organic matter prior to placement in forms.

3.03 PLACEMENT

A. Place reinforcing in accordance with approved shop drawings, support and secure reinforcement against displacement. Do not deviate from required position. Place within maximum tolerances given in ACI SPEC-117. Bars must be placed and secured before concrete is placed.

B. Splice reinforcing where indicated on drawings.

C. Install mechanical connectors in accordance with connection manufacturer's recommendations.

D. Provide templates for all column dowels.

E. Do not bend bars embedded in hardened or partially hardened concrete without approval from the Architect/Engineer. If bending is permitted, conform to procedures of ACI SPEC-301.

F. Support footing and slab on grade reinforcing. Do not lift or "step in" during placement of concrete. Use precast concrete, block, brick, or wire supports with earth bearing bases.

G. Do not displace or damage vapor barrier.

H. Reinforcing shall have the minimum concrete cover as given on the drawings.

3.04 INSTALLATION - EPOXY COATED REINFORCING

A. Do not field cut epoxy-coated reinforcing bars unless shown on Drawings or permitted by Engineer.

B. Do not use welded splices of epoxy-coated reinforcing bars unless shown on Drawings or permitted by Engineer. When used, welded splices shall conform to AWS D1.4. Welding of crossing bars (tack welding) for assembly of epoxy-coated reinforcement is prohibited.

C. Provide suitable ventilation when welding of epoxy-coated bars is required or permitted.

D. Do not use mechanical connections for epoxy-coated reinforcing unless shown on drawings or permitted by Engineer.

E. Repair coating damage due to heating, bending, cutting, welding or installation of mechanical connections, in accordance with ASTM D3963/D3963M and patching material manufacturer's recommendations.

F. Do not use epoxy-coated bars with damage, repaired and unrepaired, exceeding 2 percent of the surface area of each bar.

3.05 POST-INSTALLED REINFORCING

A. See section 03 15 10 for installation requirements.

3.06 FIELD QUALITY CONTROL

A. Structural Special Inspection

1. Structural Special Inspection shall be performed by qualified parties as specified herein, and in accordance with the provision of Section 01 45 33.
2. Concrete reinforcing in slabs on grade, strip footings without transverse reinforcement, isolated spread footings, and topping slabs does not require inspection. Additional exclusions may be noted on the structural drawings. Special Inspector need not be present during entire reinforcing installation, but must observe all required reinforcing prior to concrete placement.
3. Personnel Qualifications:
    a. Special Inspector - Structural I: ICC certified concrete inspector or a graduate civil/structural engineer, or other personnel acceptable to the structural Engineer of Record (SER), with experience in the design of structural systems of this type. Inspections shall be performed under the direct supervision of a licensed structural engineer, as defined in Section 01 45 33. The licensed engineer shall review and approve all inspection reports.
4. The Owner will provide the following inspections:

a. Inspect reinforcement in all cast in place concrete, except as noted above. Qualifications: Structural I. Verify the following:
   1) Reinforcing bar grade.
   2) Reinforcing bars are free of oil, dirt, excessive rust, and damage.
   3) Reinforcing bars are adequately tied, chaired, and supported to prevent displacement during concrete placement.
   4) Proper chair and tie wire materials are used.
   5) Proper clear distances between bars and to surfaces of concrete.
   6) Reinforcing bar size and placement.
   7) Bar laps for proper length and stagger.
   8) Bar bends for minimum diameter, slope and length.
   9) Mechanical splices are placed in accordance with the plans, specifications and reviewed shop drawings.
   10) Epoxy coating is presented at locations noted in the plans and specifications. include tie wires, chairs, bolsters, etc. Verify coating damaged is repaired in accordance with the contract requirements.

END OF SECTION 03 20 00

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Details of Construction, and General Provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

A. Section Includes: Providing all items, articles and materials listed, mentioned, or scheduled on the Drawings or herein, including all labor, materials, equipment, and incidentals necessary and required for the installation of all cast-in-place concrete indicated on the Drawings or specified herein.
B. Concrete footings.
C. Floors and slabs on grade.
   1. Including vapor barrier.
D. Concrete curing.

1.03 RELATED REQUIREMENTS

A. Section 01 45 33 - Structural Testing and Special Inspection
B. Section 03 10 00 - Concrete Forming and Accessories: Forms and accessories for formwork.
C. Section 03 20 00 - Concrete Reinforcing.
D. Section 05 12 00 - Structural Steel Framing: Embedded Structural Steel, Anchor Bolts
E. Section 07 21 00 - Insulation: vapor barrier.

1.04 REFERENCE STANDARDS

A. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
B. ACI PRC-309 - Guide for Consolidation of Concrete, American Concrete Institute; 2005.
C. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
D. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.
E. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
F. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.
G. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
H. ACI PRC-308 - Guide to External Curing of Concrete; 2016.
I. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
J. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
K. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
L. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field; 2023.
M. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2022.
N. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.
O. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2024.
P. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2025.
Q. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
R. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
S. ASTM C157/C157M - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete; 2017.
T. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2024a.

U. ASTM C231/C231M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method; 2017a.
V. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2024.
W. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2019.
X. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2024.
Y. ASTM C595/C595M - Standard Specification for Blended Hydraulic Cements; 2021.
Z. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.
AA. ASTM C1064/1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete; 2017.
BB. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
CC. ASTM C1116/C1116M - Standard Specification for Fiber-Reinforced Concrete; 2023.
DD. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method); 2021.
EE. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete; 2019.
FF. ASTM C1579 - Standard Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert); 2021.
GG. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2022.
HH. ASTM C1609/C1609M - Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading); 2019a.
II. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction; 2012 (Reapproved 2022).
JJ. ASTM D7508/D7508M - Standard Specification for Polyolefin Chopped Strands for Use in Concrete; 2020.
KK. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2020.

1.05 SUBMITTALS

A. See Division 1 for submittal procedures.
B. Concrete mix designs for each mix used. On request, include field test data used to determine required average strength (if that method was used) and field test or trial mix data used to document required average compressive strength.
C. Product data for the following products.
    1. Curing materials and compounds.
    2. Admixtures.
    3. Fiber reinforcing.
    4. Non-shrink grout.
D. Test Reports: Submit report for each test or series of tests specified.
E. Cold weather concreting procedures for information only.
F. Drawings showing construction and control joint locations and details for slabs on grade.
G. Certification of admixture conformance to chloride ion requirements.

1.06 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI SPEC-301, ACI SPEC-117, and ACI 318.
B. Follow recommendations of ACI PRC-305 when concreting during hot weather.
C. Follow recommendations of ACI PRC-306 when concreting during cold weather.

D. Fiber reinforcing supplier shall have no less than five (5) years of satisfactory product performance experience with the approved product.
E. Personnel conducting testing in accordance with ASTM E1155 to be certified by the device manufacturer.

1.07 MATERIAL DELIVERY, HANDLING, AND STORAGE

A. Materials shall be delivered in the Manufacturer's undamaged, unopened containers. Each container shall be clearly marked with the product name, manufacturer's name, batch number, component designation, and ratio of component mixtures.
B. Provide equipment and personnel to handle the materials by methods that prevent damage.
C. Promptly inspect shipments to assure that materials comply with requirements, quantities are correct, and materials are undamaged.
D. Store materials in accordance with the Manufacturer's instructions, with seals and label intact and legible. Maintain temperatures within the Manufacturer's recommended ranges.
E. Furnish delivery tickets with each load of concrete delivered to the Project. Information on each ticket shall meet requirements of ASTM C94/C94M and shall also include: type of concrete (mix number), weights of all ingredients, maximum aggregate size, allowable slump range at point of discharge, type, brand, and amount of admixture, total water in the batch, maximum amount of water that can be added at the site without exceeding design mix proportions, and amount of water added at site and initials of person adding water. Retain tickets until substantial completion unless directed otherwise.

1.08 NATIONAL VOLATILE ORGANIC COMPOUND (VOC) EMISSION STANDARDS

A. All products shall comply with the E.P.A. rulings establishing national V.O.C. emission standards for architectural coatings as listed in the Federal Register: September 11,1998 (Volume 63, Number 176), [Rules and Regulations] [Page 48848-48887].

PART 2 PRODUCTS

2.01 FORMWORK

A. Comply with requirements of Section 03 10 00.

2.02 REINFORCEMENT MATERIALS

A. Comply with requirements of Section 03 20 00.

2.03 CONCRETE MATERIALS

A. Cement:
   1. Portland Cement: ASTM C150/C150M, Type I - Normal.
   2. Blended Hydraulic Cement: ASTM C595/C595M, Type IL - Portland-limestone.
B. Fine and Coarse Aggregates: ASTM C33/C33M.
   1. Maximum aggregate size as specified in mix design schedule.
   2. Alkali Silicate Reactivity: Expansion of fine aggregate tested per ASTM C1260 shall not exceed 0.15 percent. If fly ash or other pozzolans are used to reduce shrinkage to meet this requirement, expansion of fine aggregate tested per ASTM C1260 without fly ash or other pozzolans shall not exceed 0.25 percent.
C. Fly Ash: ASTM C618, Class C or F.
D. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.
E. Synthetic Micro Fiber Reinforcing: Fibrillated or Monofilament.
   1. Fibrillated Fibers: 100% virgin polyolefin (polypropylene or polyethylene), graded or minimum ¾" uniform length,, complying with ASTM D7508/D7508M for use in producing Type III Synthetic Fiber-Reinforced Concrete meeting the requirements of ASTM C1116/C1116M. Fibermesh 300: Propex Concrete Systems, Grace Fibers: W.R. Grace, Ultra-Net: Forta Fibers, or approved equal.
      a. Dosage: 1.5 lb per cubic yard.
   2. Monofilament Fibers: Complying with ASTM D7508/D7508M for use in producing Type III Synthetic Fiber-Reinforced Concrete meeting the requirements of ASTM C1116/C1116M.

a. Minimum crack reduction ratio (CRR) of 80 percent when tested in accordance with ASTM C1579.
b. Dosage: as recommended by manufacturer to meet CRR requirement.

2.04 ADMIXTURES

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
B. Air Entrainment Admixture: ASTM C260/C260M.
C. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
D. Accelerating Admixture: ASTM C494/C494M Type C.
E. Water Reducing Admixture: ASTM C494/C494M Type A.
F. Prohibited Admixtures: Calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions.

2.05 ACCESSORY MATERIALS

A. Underslab Vapor Barrier: See Section 07 21 00 - Insulation
B. Granular fill under vapor barrier: Clean mixture of crushed aggregates and sand, ASTM D448, size 10, with 85-100% passing the No.4 sieve and 10-30% passing the No. 100 sieve. Meet requirements of ASTM C33/C33M for deleterious substance limits in fine aggregates.
C. Non-Shrink Grout: ASTM C1107/C1107M; Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
1. Conformance to ASTM C1107/C1107M shall occur with a minimum temperature range of 45°F to 90°F, a fluid consistency, and a minimum 30 minute working time.

2.06 BONDING AND JOINTING PRODUCTS

A. Slab Isolation Joint Filler: 1/4 inch thick, height equal to slab thickness, with removable top section forming 1/2 inch deep sealant pocket after removal.

2.07 CURING MATERIALS

A. All curing agents and sealers shall have no adverse effect on finishes, traffic topping, or other sealers. Coordinate with the appropriate finish manufacturer and receive written confirmation before applying.
B. Moisture-Retaining Cover: ASTM C171; regular curing paper, white curing paper, white polyethylene film at temperatures above 60 degrees F., black polyethylene film at temperatures below 80 degrees F., clear polyethylene, or white burlap-polyethylene sheet at temperatures above 60 degrees F.
C. Curing and Sealing Compound: ASTM C1315, Type 1, Class A, VOC compliant, 25% minimum solids.
D. Exterior Concrete Curing Compound: Wax base, membrane forming curing compound, ASTM C309, Type II, white pigmented.

2.08 CONCRETE MIX DESIGN REQUIREMENTS

A. Submit concrete mix design for each type of concrete at least 30 days prior to the proposed start of placement. Mix designs must be reviewed prior to pouring concrete. Review is for conformance with specification requirements only. Contractor is responsible for performance.
B. Concrete shall conform to the requirements of ASTM C94/C94M (Option A) unless other requirements of this project specification are more stringent.
C. Provide concrete with workability such that it will fill the forms, without voids or honeycombs, when properly vibrated, without permitting materials to separate or excess water to collect on the surface.
D. Self-consolidating concrete may be used at Contractor's option where desired and shall be used where required for architectural finish or where necessary to achieve proper consolidation in locations of reinforcing congestion. Modify standard mixes as appropriate to achieve self-consolidating properties.
E. Slump at point of discharge: as specified by concrete supplier. Include design slump in mix design submittal.
F. Flow for self-consolidating concrete: 20"-30".
G. Proportioning Normal Weight Concrete: ACI SPEC-301. Establish proportions based on the standard practices contained in ACI PRC-211.1.

H. Determine required average strength per ACI SPEC-301 .
I. Concrete Strength: Document that mixes produce required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.
J. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.
K. Fiber Reinforcement: Add to mix where specified in the mix design schedule as recommended by manufacturer for specific project conditions but not less than the minimum rate show on drawings.

2.09 CONCRETE MIX DESIGN SCHEDULE

A. Normal Weight Concrete: Footings
   1. Minimum Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 3,000 psi.
   2. Water-Cement Ratio: Maximum 0.62 by weight.
   3. Maximum Aggregate Size: 1 1/2" Class 1S.
   4. Maximum Chloride Ion Content: 0.30 percent by weight of cement.
B. Normal Weight Concrete: Walls not exposed to view, piers or columns integral with those walls, and isolated below grade piers
   1. Minimum Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,000 psi.
   2. Water-Cement Ratio: Maximum 0.52 by weight.
   3. Maximum Aggregate Size: 3/4" Class 1S.
   4. Maximum Chloride Ion Content: 0.30 percent by weight of cement.
C. Normal Weight Concrete: Exterior Concrete
   1. Exterior concrete includes: exterior aprons and stoop slabs, exterior walls, piers, and columns, and other similar conditions.
   2. Minimum Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 5,000 psi.
   3. Fly Ash Content: Maximum 25 percent of cementitious materials by weight.
   4. Synthetic Micro Fiber Reinforcement: Required at slabs only.
   5. Water-Cement Ratio: Maximum 0.40 by weight.
   6. Total Air Content: 3.5 percent to 6.5 percent.
   7. Maximum Aggregate Size: 3/4" Class 5S.
   8. Maximum Chloride Ion Content: 0.15 percent by weight of cement.
D. Normal Weight Concrete: Slabs on grade
   1. Minimum Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,000 psi.
   2. Synthetic Micro Fiber Reinforcement.
   3. Water-Cement Ratio: Maximum 0.45 by weight.
   4. Maximum Aggregate Size: 3/4" Class 2S, well graded to achieve shrinkage limits specified.
   5. Maximum 28-day shrinkage per ASTM C157/C157M: 0.05 percent.
   6. Maximum Chloride Ion Content: 0.30 percent by weight of cement.
E. Normal Weight Concrete: Masonry Core Fill and Bond Beams
   1. Minimum Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 3,000 psi.
   2. Water-Cement Ratio: Maximum 0.60 by weight.
   3. Maximum Aggregate Size: 3/8" Class 1S.
   4. Maximum Chloride Ion Content: 0.15 percent by weight of cement.
   5. Self-consolidating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

A. Verify that anchors, seats, plates, embeds, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement. “Wet sticking” of structural steel embeds and anchor rods is not permitted.

B. Do not embed pipes other than non-aluminum electrical conduit or snow melting pipes in any structural concrete.

1. Any pipes embedded in concrete, even those meeting the guidelines given herein, are subject to acceptance by Architect. Remove any unacceptable pipes.
2. Outside diameter of pipes placed in slabs and walls shall not exceed 25 percent of the thickness of the slab or wall and shall be placed in groups of not more than 3. Space pipes within a group at not less than 4 diameters clear. Space groups of pipes at not less than 48 diameters clear.
3. Maximum total dimension or area of pipes and their fittings embedded in concrete beams and columns shall not exceed, at any location, 15 percent of least section dimension or 4 percent of the gross cross sectional area.

C. Where new concrete is to be bonded to existing or previously placed concrete, clean existing surface to remove dust, dirt, grease, oil, curing compounds and other items that would be detrimental to bonding. Saturate existing surface with clean water (8 hours minimum), remove excess water, and slush with a neat cement grout immediately before placing new concrete.

D. Protect existing concrete work to be exposed to view and other finished materials from damage and staining resulting from concreting operations. Cover sills, ledges and other surfaces with protective coverings to protect the work.

E. Slabs on Grade:

1. Verify subgrade compaction tests have been performed and are accepted.
2. Verify subgrade is level and within acceptable tolerances.
3. Verify subgrade is substantially dry with no freestanding water, muddy spots, or soft spots and is free from snow or ice.
4. Verify completion of all underfloor mechanical and electrical work.
5. Provide 3 inch minimum cover bottom and 3 inch minimum cover sides at electrical conduits and other embedded items.

F. Vapor Barrier Placement

1. Install in accordance with ASTM E1643 and manufacturer's written instructions.
    a. Place with longest dimension parallel with the direction of the concrete pour.
    b. Lap over footings and seal to foundation walls with vapor-proofing mastic.
    c. Overlap joints 6 inches minimum and seal with manufacturer's tape.
    d. Seal all penetrations including, but not limited to, pipes, conduits, columns, and piers with pipe boots in accordance with manufacturer's written instructions. No unsealed penetrations will be permitted.
    e. Terminate at wall under termination bar and seal with mastic per Division 07 and as detailed on Architectural drawings.
    f. Repair damaged areas by applying patches of vapor barrier, overlapping damaged area 6" and sealing on all four sides with tape.

3.03 CONCRETE MIXING

A. Transit Mixers: Comply with ASTM C94/C94M.

B. Use cooled or heated water in accordance with ACI PRC-306 and ACI PRC-305.

C. Air-entraining and chemical admixtures, if approved, shall be charged into mixer as a solution and dispensed by an automatic dispenser or similar metering device. Powdered admixtures shall be weighted

or measured by volume as recommended by the manufacturer. Superplasticizer may be added at the job site to maintain slump.

D. Two or more admixtures may be used in same concrete, provided such admixtures are added separately during batching sequence. Admixtures used in combination shall retain full efficiency and have no deleterious effect on concrete or on properties of each other.

E. For fiber reinforced concrete, introduce fibers to mix when recommended by fiber supplier to maximize disbursement through the mix and to minimize balling of fibers.

F. Ready mixed concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of rated capacities. Schedule and dispatch trucks from the batching point so that they shall arrive at the site of the work just before the concrete is required to avoid excessive mixing of concrete while waiting.

G. Discharge at the site shall begin within one (1) hour after charging. Concrete may be used as long as it is of such slump that it can be placed and properly consolidated without the addition of water to the batch (other than water added prior to the start of discharge as given below). If elapsed time since batching exceeds 90 minutes, or if drum has revolved more than 300 revolutions since batching, test air content, slump, and temperature for conformance to this specification prior to placing. In no case shall the time between batching and complete discharge exceed 120 minutes. Do not permit retempering of concrete. Discard concrete that has obtained its initial set.

H. Do not add water after the initial introduction of the mixing water for the batch, except at the start of discharge, subject to the conditions below. In this case, the producer may add water in an amount not exceeding that allowed to achieve the design water/cement ratio. The drum blades shall then be turned an additional 30 revolutions minimum at mixing speed. Water shall not be added to the batch at any later time. Reject concrete if water is added and these conditions are not met.
   1. The measured slump of the concrete is less than that specified in the mix design.
   2. No more than 60 minutes have elapsed from the time of batching.
   3. The ready-mix plant is notified and approves.
   4. Truck tickets indicate maximum amount of water to be added.
   5. Water is added in a manner to control volume.
   6. Special Inspector is notified, if concrete placement requires inspection.

I. Maximum concrete temperature delivered to Project site shall be 85°F.

J. To use materials other than those accepted originally, or if the materials from the source originally accepted change in characteristics, make additional tests with proposed new materials that will verify production of concrete meeting with the stated requirements without causing objectionable change in the color or appearance of the structure. Pay the testing agency for these additional tests. Do not use concrete made from such different materials until the Architect has given his approval.

K. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished by the Vendor, the Architect may order such changes in the proportions or materials, or both, to secure the desired properties, subject to the stated requirements. Make any changes so ordered without extra compensation.

3.04 PLACING CONCRETE

A. Place concrete in accordance with ACI SPEC-301. Follow recommended practice of ACI PRC-304.

B. Place concrete for floor slabs following recommended practices of ACI PRC-302.1.

C. Do not place in rain, sleet or snow unless exposed concrete surface is protected from moisture.

D. Ensure reinforcement, inserts, and embedded parts will not be disturbed during concrete placement.

E. If, for any reason, the concrete pour is delayed for more than 45 minutes, bulkhead pour at last acceptable construction joint. Immediately remove excess concrete and clean all forms and in situ concrete surfaces.

F. Do not permit concrete to drop more than 4 feet from its point of release to mixers, hoppers, or conveyances. Use tremmies, chutes, or pumps to limit drop when placing columns and walls.

G. Deposit concrete in wall forms in layers not greater than 24 inches in depth. Consolidate each layer before the succeeding layer is placed.
H. Place concrete as near as possible to its final position to prevent segregation. Do not use vibrators to transport concrete.
I. Do not interrupt successive placement; do not permit cold joints to occur.
J. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
K. Immediately remove concrete spilled on existing surfaces.
L. Concrete at tops of forms: Strike concrete at top of wall, footing, and pier forms. Smooth and float to texture comparable to adjacent formed surfaces.

3.05 JOINTS

A. Vertical construction joints in walls shall be a maximum of 80 feet on center and shall be located as shown on structural drawings. Vertical control joints in wall shall be a maximum of 20 feet on center between construction joints and shall be located as shown on the structural drawings. If locations are not shown, locate joints at edges of piers integral with wall and near corners and in concealed locations where possible.
B. Locate construction joints for beams, slabs, joists and girders in the middle 1/3 of the span. Place so they do not compromise the strength of the structure. Offset joints in a girder at least twice the beam width from a beam-girder intersection.
C. Horizontal joints in walls and columns shall be at underside of slabs, beams and girders and at top of footings. At least 24 hours shall elapse between placing concrete in a wall or column and placing concrete in an area supported by the wall or column.
D. Reinforcing shall be continuous across construction joints. Provide dowels where detailed or requested. Joints in walls shall be keyed with longitudinal keys at least 1-1/2 inches deep unless detailed otherwise.

3.06 SLAB JOINTING

A. Locate slab on grade construction and control joints as given on Drawings and submit drawings showing proposed locations. Cut joints as soon as concrete has hardened sufficiently to prevent aggregate dislodgement. Use a "Soff Cut" saw to cut to a depth of 1 1/4" immediately after final finishing. Use a conventional saw to cut to a depth of one-fourth the slab thickness or as shown on the drawings. Complete sawing within 12 hours of placement.
B. Anchor joint fillers and devices to prevent movement during concrete placement.
C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
    1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.

3.07 CONSOLIDATION

A. Consolidation of concrete shall conform to ACI SPEC-301, unless modified herein.
B. Follow recommended practices of ACI PRC-309, unless modified herein.
C. Consolidate concrete using internal vibrators.
D. Maintain a spare vibrator at the Project Site during all placing operations.

3.08 CONCRETE FINISHING

A. Concrete Finish Schedule
    1. Concealed walls and columns: Surface finish - 1.0 (SF-1.0).
    2. Exposed columns: Surface finish - 2.0 (SF-2.0).
    3. Floors to receive carpeting: Troweled finish.
    4. Floors to receive mortar setting beds for tile or pavers: Scratched finish.
    5. Exterior aprons: Broom finish.
    6. Floors to receive thin-set ceramic tile, resilient flooring, and vinyl tile: Flat troweled finish.
B. Formed Surfaces

1. Repair surface defects, immediately after removing formwork.
2. Provide finishes per ACI SPEC-301 as scheduled and to the following tolerances.
3. SF-1.0: Surface finish 1.0 per ACI SPEC-301. Rub down or chip off fins or other raised areas 1 inch or more in height. Class C surface tolerance per ACI SPEC-117.
4. SF-2.0: Surface finish 2.0 per ACI SPEC-301. Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Class B surface tolerance per ACI SPEC-117.

C. Unformed Surfaces
1. Provide finishes per ACI SPEC-301 as scheduled and to the following tolerances (F Numbers) per ACI SPEC-117 and measured according to ASTM E1155.
   a. Troweled Finish: Moderately flat tolerance.
      1) F(F): Specified Overall Value of 25; Minimum Localized Value of 15.
      2) F(L): Specified Overall Value of 20; Minimum Localized Value of 12.
   b. Flat Troweled Finish: Flat tolerance
      1) F(F): Specified Overall Value of 35; Minimum Localized Value of 21.
      2) F(L): Specified Overall Value of 25; Minimum Localized Value of 15.
   c. Scratched Finish: Conventional tolerance.
      1) F(F): Specified Overall Value of 20; Minimum Localized Value of 12.
      2) F(L): Specified Overall Value of 15; Minimum Localized Value of 10.
   d. Broom Finish: Moderately flat tolerance.
      1) F(F): Specified Overall Value of 25; Minimum Localized Value of 15.
      2) F(L): Specified Overall Value of 20; Minimum Localized Value of 12.
2. Clean exposed concrete to remove laitance, efflorescence and stains.

3.09 CURING AND PROTECTION

A. Comply with requirements of ACI PRC-308 as amended by this section. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature above 55° F for the period necessary for hydration of cement and hardening of concrete as follows:
1. Normal concrete: Not less than seven days.

C. Curing may be terminated earlier than the minimum time above if at least one of the following conditions is met:
1. At least (4) 6x12-inch or (5) 4x8-inch field cylinders for each pour, prepared and cured according to ASTM C31/C31M alongside the concrete they represent, reach 70% of the specified 28-day strength.
2. The concrete temperature is maintained above 50°F and laboratory cylinders reach 85% of the specified 28-day strength.

D. Formed Surfaces: Cure by moist curing with forms in place for full curing period. If forms are removed during the curing period, cure by one of the methods specified for unformed surfaces.
1. Keep steel forms heated by the sun and all wood forms wet during the curing period.

E. Unformed Surfaces: Apply curing materials as soon as finishing operations are complete and the concrete's sufficiently hard to be undamaged by the curing process.
1. Waterproof paper or polyethylene film: Use appropriate color of film based on ambient temperature. Sprinkle concrete with water as necessary during application of covering. Lap edges and ends at least 6 inches, and seal laps. Weight down covering to prevent movement. Patch holes and tears that occur during the curing period.
2. Curing Compounds: Apply strictly according to the manufacturer's instructions using low pressure spray equipment.
   a. Maximum 300 square feet per gallon for curing and sealing compound.
3. Use the following methods:

a. Interior floors and stairs exposed in the finished work or receiving mastic applied adhesives: Cure using a curing and sealing compound.
    1) For surfaces exposed in the finished work, provide a second coat of acrylic curing and sealing compound immediately prior to substantial completion. Clean floors, and apply sealer strictly according to manufacturer's instructions.
b. Interior surfaces receiving adhesive applied finishes: Cure using wet curing methods or by covering with waterproof paper or polyethylene film.
    1) Curing and sealing compound may be used upon receipt of a letter from the adhesive manufacturer that this compound is compatible with the adhesive.
c. Exterior concrete: Cure using exterior concrete curing compound.
d. All other unformed surfaces: Cure using a strippable curing compound, by wet curing methods, or by covering with waterproof paper or polyethylene film.

4. Protect concrete from excessive changes in temperature during the curing period and at the termination of the curing process. Changes in the temperature of the concrete shall be as uniform as possible and shall not exceed 5° F in any one hour or 50° F in any 24 hour period.

3.10 HOT WEATHER CONCRETING

A. Apply recommended practices of ACI PRC-305 when wind, temperature and humidity conditions cause evaporation rates (using Figure 2.1.5 of ACI PRC-305) exceeding the following:
    1. 0.2 lb/sq ft/hr for concrete with Portland cement only.
    2. 0.1 lb/sq ft/hr for concrete with Portland cement and fly ash.
    3. 0.05 lb/sq ft/hr for concrete with Portland cement and silica fume.
B. Determine and document expected evaporation rate for the duration of concrete pour.
C. Wet or fog forms and reinforcing immediately prior to placement to bring temperature to ambient conditions.
D. Maintain surface moisture during the period immediately after placement and before final finishing by using wind breaks, fog sprayers, evaporation retarders, or shade (individually or in combination) to prevent plastic shrinkage cracking.
    1. Use evaporation retarders according to manufacturer's instructions. Do not use as a finishing aid.

3.11 COLD WEATHER CONCRETING

A. Concrete placed during cold weather shall conform to the requirements of ACI PRC-306.
B. Cold weather is defined as 3 or more successive days when the average daily outdoor temperature is less than 40°F.
C. All surfaces, including subgrade and reinforcing larger than a #8 bar shall be above 35°F prior to placing concrete. All reinforcing bars #8 and smaller shall be above 10°F prior to placing concrete. Surfaces shall not be more than 10° warmer than the minimum concrete temperatures required by ACI PRC-306.
D. Maintain cold weather protection for the following duration but not less than the duration specified in "Curing and Protection" above:
    1. Maintain protection for a minimum of 48 hours after placement of concrete.
    2. Maintain protection for columns and supported slabs until at least 4 field cylinders, prepared and cured in accordance with ASTM C31/C31M, reach 85 percent of the specified 28-day strength, or, laboratory cured cylinders reach the specified 28-day strength.
E. Submit detailed procedures for cold weather concreting for engineer's information only.
F. Follow recommended practices of ACI PRC-306. Subject to other requirements of this section, a non-chloride accelerator may be used to normalize initial set and for early strength gain.

3.12 FIELD QUALITY CONTROL

A. Provide free access to concrete operations at project site and cooperate with appointed firm.
B. Structural Testing and Special Inspection
    1. Structural Testing and Special Inspection shall be performed by qualified parties as specified herein, and in accordance with the provisions of Section 01 45 33.

2. Personnel Qualifications
    a. Testing Technician: Technical I - ACI Certified Concrete Field Testing Technician, Grade I, employed by a testing laboratory with C.C.R.L. certification at the National Bureau of Standards, under the direct supervision of a licensed civil/structural engineer. The licensed engineer shall review and approve all reports.
    b. Special Inspector – Structural I: ICC Certified Concrete Inspector, ACI Concrete Construction Inspector, or a graduate civil/structural engineer, or other personnel acceptable to the Structural Engineer of Record (SER), with experience in the design of structural systems of this type. Inspections shall be performed under the direct supervision of a licensed structural engineer, as defined in Section 01 45 33. The licensed engineer shall review and approve all inspection reports.
3. The Owner will provide the following tests and inspections:
    a. Tests for cast in place concrete. Qualifications: Technical I.
        1) Compression test specimens: ASTM C31/C31M. One set of four 6x12-inch standard cylinders or five 4x8-inch cylinders of concrete for each compressive strength test. Mold and store cylinders for laboratory cured specimens.
        2) Compressive strength tests: ASTM C39/C39M . Minimum one strength test for each day's pour, or one strength test for each 150 cubic yards placed. For slabs and walls, no less than one strength test for every 5,000 square feet. A strength test shall be defined as one set of five cylinders, subdivided as follows: One specimen tested at 7 days for information, three at 28 days for acceptance, and one specimen retained in reserve for later testing if required. When frequency of testing will provide less than five strength tests for a given class of concrete, conduct at least five strength tests from randomly selected batches. If fewer than five batches are used, conduct one test from each batch. A class of concrete is defined as an individual concrete mix design. A batch of concrete is defined as an individual proportion of concrete used in construction (e.g., a single truck load).
        3) Slump: ASTM C143/C143M. One test at point of discharge for each set of compression test specimens; additional tests when concrete consistency appears to have changed.
        4) Air entrainment: ASTM C231/C231M, or ASTM C173/C173M where C231 cannot be used. Test the first batch of air entrained concrete and one additional test for each set of compression test specimens.
        5) Concrete temperature: ASTM C1064/1064M. Test hourly when air temperature is below 40°F or above 80°F and each time a set of compression test specimens is made.
    b. Concrete mix verification. Qualifications: Technical I. Verify the following:
        1) Mixer truck trip ticket conforms to approved mix design.
        2) Total water added to mix on site does not exceed that allowed by concrete mix design.
        3) Concrete quality is indicative of adequate mixing time, consistency, and relevant time limits.
    c. Observe preparation for and placement of all concrete, excluding slabs on grade, strip footings without transverse reinforcement, and isolated spread footings. Additional exclusions may be noted on the structural drawings. Special Inspector must be present during entire concrete pour. Qualifications: Structural I. Verify the following:
        1) Acceptable general condition of concrete base prior to placement.
        2) Concrete conveyance and depositing avoids segregation and contamination.
        3) Concrete is properly consolidated.
        4) Reinforcement remains at proper location.

d. Observe protection and curing methods for all concrete, excluding slabs on grade, strip footings without transverse reinforcement, and isolated spread footings. Additional exclusions may be noted on the structural drawings. Observations to be made periodically during the curing period. Qualifications: Structural I. Verify the following:
    1) Specified curing procedures are followed.
    2) Specified hot and cold weather procedures are followed.
e. Observe all bolts, rods and structural steel embeds installed in concrete. Qualifications: Structural I. Verify the following:
    1) Specified size, type, spacing, configuration, embedment, and quantity.
    2) Proper concrete placement and consolidation around all bolts, rods and structural steel embeds.

C. Contractor Requirements:
1. Provide services of an independent laboratory to perform the following:
    a. Make and test additional cylinders to determine time for form removal.
    b. Make and test additional cylinders to determine termination of curing procedures.
    c. Make and test additional cylinders to determine termination of cold weather practices.
2. Provide the services of a qualified technical representative to instruct the construction team in proper batching, mixing, placement, and finishing of fiber reinforced concrete.

3.13 DEFECTIVE CONCRETE

A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.

B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.

C. Acceptance criteria for concrete strength tests shall be as outlined in section 26.12 of ACI 318. If concrete does not meet acceptance criteria, investigation generally following the provisions of section 26.12.4 of ACI 318 will be used at the discretion of the Structural Engineer of Record. Contractor shall reimburse Owner for all costs associated with this investigation. If, in the judgment of the Structural Engineer of Record, the structural adequacy cannot be shown by this investigation, the Contractor shall remove and replace the concrete in question.

3.14 CLEAN-UP

A. Perform concrete washout only in designated area as indicated by either Division 31 section Erosion Control or the project NPDES permit.

END OF SECTION 03 30 00

SECTION 04 72 00
CAST STONE MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Architectural cast stone.
B. Units required are indicated on drawings as "cast stone".
C. Units required are:
   1. Exterior wall units: cast stone cap at canopy column enclosure.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Include elevations, dimensions, layouts, profiles, cross sections, reinforcement, exposed faces, arrangement of joints, anchoring methods, anchors, and piece numbers.
C. Verification Samples: Pieces of actual cast stone components not less than 6 inches (152 mm) square, illustrating range of color and texture to be anticipated in components furnished for the project.
D. Source Quality Control Test Reports.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver cast stone components secured to shipping pallets and protected from damage and discoloration. Protect corners from damage.
B. Number each piece individually to match shop drawings and schedule.
C. Store cast stone components and installation materials in accordance with manufacturer's instructions.
D. Store cast stone components on pallets with nonstaining, waterproof covers. Ventilate under covers to prevent condensation. Prevent contact with dirt.
E. Protect cast stone components during handling and installation to prevent chipping, cracking, or other damage.
F. Store mortar materials where contamination can be avoided.
G. Schedule and coordinate production and delivery of cast stone components with unit masonry work to optimize on-site inventory and to avoid delaying the work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Architectural Cast Stone:
   1. Any current producer member of the Architectural Precast Association.
   2. Any current producer member of the Cast Stone Institute.
   3. Products as selected from American Artstone: Cast Stone; www.american-artstone.com

2.02 ARCHITECTURAL CAST STONE

A. Cast Stone: Architectural concrete product manufactured to simulate appearance of natural granite, complying with ASTM C1364.
   1. Compressive Strength: As specified in ASTM C1364; calculate strength of pieces to be field cut at 80 percent of uncut piece.
   2. Freeze-Thaw Resistance: Demonstrated by laboratory testing in accordance with ASTM C1364.
   3. Surface Texture: Fine grained texture, with no bugholes, air voids, or other surface blemishes visible from distance of 20 feet (6 meters).
   4. Linear Shrinkage: As specified by ASTM C426. Shrinkage shall not exceed 0.065%.
   5. Color: Selected by Architect from manufacturer's full range.
   6. Remove cement film from exposed surfaces before packaging for shipment.
B. Shapes: Provide shapes indicated on drawings.
   1. Variation from Any Dimension, Including Bow, Camber, and Twist: Maximum of plus/minus 1/8 inch (3 mm) or length divided by 360, whichever is greater, but not more than 1/4 inch (6 mm).
   2. Unless otherwise indicated on drawings, provide:
      a. Wash or slope of 1:12 on exterior horizontal surfaces.
      b. Drips on projecting components, wherever possible.
      c. Raised fillets at back of sills and at ends to be built in.

C. Reinforcement: Provide reinforcement as required to withstand handling and structural stresses; comply with ACI CODE-318.
   1. Pieces More than 24 inches (610 mm) in Any Dimension: Provide full length two-way reinforcement of cross-sectional area not less than 0.25 percent of unit cross-sectional area.

2.03 MATERIALS

A. Portland Cement: ASTM C150/C150M.
   1. For Units: Type I, white or gray as required to match Architect 's sample.
B. Coarse Aggregate: ASTM C33/C33M, except for gradation; granite, quartz, or limestone.
C. Fine Aggregate: ASTM C33/C33M, except for gradation; natural or manufactured sands.
D. Pigments: ASTM C979, inorganic iron oxides; do not use carbon black.
E. Admixtures: ASTM C494/C494M, C260, C618, C989.
F. Water: Potable.
G. Reinforcing Bars: ASTM A615/A615M, Grade 40 (40,000 psi) (280 MPa), deformed bars, galvanized.
   1. Galvanized in accordance with ASTM A767/A767M, Class I or Epoxy coated in accordance with ASTM A775/A775M
H. Steel Welded Wire Reinforcement: ASTM A1064/A1064M, galvanized or ASTM A884/A884M, epoxy coated.
I. Embedded Anchors, Dowels, and Inserts: Type 304 stainless steel, of type and size as required for conditions.

2.04 SOURCE QUALITY CONTROL

A. Test compressive strength and absorption of specimens selected at random from plant production.
   1. Test in accordance with ASTM C642.
   2. Select specimens at rate of 3 per 500 cubic feet (3 per 14 cubic m), with a minimum of 3 per production week.
   3. Submit reports of tests by independent testing agency, showing compliance with requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine construction to receive cast stone components. Notify Architect if construction is not acceptable.
B. Do not begin installation until unacceptable conditions have been corrected.

3.02 INSTALLATION

A. Refer to Section 04 20 00 Non-Bearing Unit Masonry.

3.03 TOLERANCES

A. Joints: Make all joints 3/8 inch (9.5 mm), except as otherwise detailed.
   1. Rake mortar joints 3/4 inch (19 mm) for pointing.
   2. Remove excess mortar from face of stone before pointing joints.
   3. Point joints with mortar in layers 3/8 inch (9.5 mm) thick and tool to a slight concave profile.
   4. Leave the following joints open for sealant:
      a. Head joints in top courses, including copings, parapets, cornices, sills, and steps.
      b. Joints in projecting units.
      c. Joints between rigidly anchored units, including soffits, panels, and column covers.
      d. Joints below lugged sills and stair treads.
      e. Joints below ledge and relieving angles.
      f. Joints labeled "expansion joint".
B. Installation Tolerances:
   1. Variation from Plumb: Not more than 1/8 inch in 10 feet (3 mm in 3 m) or 1/4 inch in 20 feet (6 mm in 6 m) or more.
   2. Variation from Level: Not more than 1/8 inch in 10 feet (3 mm in 3 m) or 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch (9 mm) maximum.

3. Variation in Joint Width: Not more than 1/8 inch in 36 inches (3 mm in 900 mm) or 1/4 of nominal joint width, whichever is less.
4. Variation in Plane Between Adjacent Surfaces (Lipping): Not more than 1/16 inch (1.5 mm) difference between planes of adjacent units or adjacent surfaces indicated to be flush with units.

3.04 REPAIR

A. Repair chips and other surface damage noticeable when viewed in direct daylight at 20 feet (6 m).
B. Repair with matching touch-up material provided by the manufacturer and in accordance with manufacturer's instructions.
C. Repair methods and results subject to Architect 's approval.

3.05 CLEANING

A. Clean completed exposed cast stone after mortar is thoroughly set and cured.
1. Wet surfaces with water before applying cleaner.
2. Apply cleaner to cast stone in accordance with manufacturer's instructions.
3. Remove cleaner promptly by rinsing thoroughly with clear water.
4. Do not use acidic cleaners.

END OF SECTION 04 72 00

SECTION 04 73 00
MANUFACTURED STONE MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Adhered manufactured stone masonry veneer (AMSMV).
B. Installation materials.
C. Accessories.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data for AMSMV units, mortar, lath, rainscreen drainage material, and water-resistive barrier, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Color charts.
   4. Installation methods.
C. Shop Drawings: Submit detail drawings depicting proper installation and flashing techniques. Coordinate locations with those found on drawings.
D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
E. Verification Samples: For each finish product specified, two samples, minimum size 12 inches (305 mm) square, representing actual product, color, patterns and texture.
F. Samples: Submit four samples of AMSMV units to illustrate color, texture, and extremes of color range.
G. Evaluation Service Reports: Show compliance of AMSMV with specified requirements of ICC-ES AC51.
H. Manufacturer's Certificate: Certify that AMSMV units and mortar meet or exceed specified requirements.
I. Manufacturer's Qualification Statement.
J. Installer's Qualification Statement.
K. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
L. Specimen Warranty.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum ten years of documented experience.
B. Installer Qualifications: Company specializing in performing work of type specified, with at least five years of documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.
B. Prevent mechanical damage and contamination by other materials.
C. Protect products from precipitation combined with freezing temperatures. Do not install products with visible frozen moisture.
D. Protect Portland cement based materials from moisture and humidity. Store under cover off the ground in a dry location.

1.05 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.
B. Maintain materials and surrounding air temperature to minimum 40 degrees F (5 degrees C) prior to, during, and 48 hours after completion of masonry work.
C. Maintain materials and surrounding air temperature to maximum 90 degrees F (32 degrees C) prior to, during, and 48 hours after completion of masonry work.

1.06 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Correct defective work within a five year period after Date of Substantial Completion.

C. Provide 50 year manufacturer warranty for AMSMV.
D. Provide 15 year manufacturer warranty for mortar and other installation materials used in exterior installations over steel or wood framing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Adhered Manufactured Stone Masonry Veneer (AMSMV):
   1. Coronado Stone Products: www.coronado.com/#sle.
   2. Cultured Stone: www.culturedstone.com/#sle.
   3. Dutch Quality Stone: www.dutchqualitystone.com/#sle.
   4. Eldorado Stone: www.eldoradostone.com/#sle.
   5. StoneCraft Industries: www.stonecraft.com/#sle.
   6. Boulder Creek Stone Products.
   7. Substitutions: See Section 01 60 00 - Product Requirements (Non-Wold Master - For Reference Only).

2.02 ADHERED MANUFACTURED STONE MASONRY VENEER (AMSMV)

A. AMSMV: Cast masonry units using a mixture of cement, lightweight aggregates, concrete additives and color pigments to replicate appearance of natural stone and designed to be applied with a cementitious mortar to a backing surface, complying with ASTM C1670/C1670M and ICC-ES AC51.
   1. Style: As indicated on drawings.
   2. Color, Texture, Range, Special Shapes: As indicated on drawings.
B. AMSMV Trim: Provide wall caps and drip ledges.
C. Accessory Components: Provide light stones.

2.03 MORTAR APPLICATIONS

A. At Contractor's option, mortar may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.
B. Mortar Color: Natural gray unless otherwise indicated.
C. Dash Bond Coat: One part Portland cement, with maximum two parts sand.
D. Scratch Coat Mortars: Scratch coat mortars for application directly to metal lath.
   1. Site-Mixed: ASTM C270, Type N or Type S, using the Proportion Method as specified in Section 04 05 11.
   2. Prepackaged/Preblended: ASTM C1714/C1714M, Type N or Type S.
E. Setting Bed Mortars: Setting bed used to adhere AMSMV units to scratch coat mortar or to bondable concrete or concrete masonry.
   1. Site-Mixed: ASTM C270, Type S, using the Proportion Method as specified in Section 04 05 11.
   2. Prepackaged/Preblended: ASTM C1714/C1714M, Type S.
   3. Prepackaged/Preblended Latex Modified: ANSI A118.4 or ANSI A118.15.
F. Setting Bed Mortars: Setting bed used to adhere AMSMV units to cement board.
   1. Prepackaged/Preblended Latex Modified: ANSI A118.4 or ANSI A118.15.
G. Pointing Mortars: Pointing or grouting mortars used to fill the joints between individual AMSMV units once the setting bed mortar has sufficiently cured.
   1. Site-Mixed: ASTM C270, Type N or Type S, using the Proportion Method as specified in Section 04 05 11.
   2. Prepackaged/Preblended: ASTM C1714/C1714M, Type N or Type S.
   3. Prepackaged/Preblended Latex Modified: ANSI A118.4 or ANSI A118.15.

2.04 MORTAR MIXES

A. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
   1. Type: Type S.
   2. Color: Standard gray.

3. Manufacturers:
    a. Amerimix, an Oldcastle brand: www.amerimix.com/#sle.
    b. Substitutions: See Section 01 60 00 - Product Requirements (Non-Wold Master - For Reference Only).

B. Packaged Dry Material for Mortar for Unit Masonry: Premixed masonry cement and mason's sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
1. Type: Type N.
2. Color: Standard gray.
3. Manufacturers:
    a. Amerimix, an Oldcastle brand: www.amerimix.com/#sle.
    b. The QUIKRETE Companies: www.quikrete.com/#sle.
    c. Substitutions: See Section 01 60 00 - Product Requirements (Non-Wold Master - For Reference Only).

C. Mixing: Use mechanical batch mixer and comply with referenced standards.

2.05 ACCESSORIES

A. Metal Lath with Rainscreen Drainage Material: Factory-assembled combination of mesh drainage material and metal lath.
1. Diamond Mesh Metal Lath: ASTM C847, galvanized, self-furring.
    a. Weight: To suit application and as specified in ASTM C841 for framing spacing.
    b. Weight: 2.5 lb/sq yd (1.4 kg/sq m), minimum.
2. Manufacturers:
    a. Mortar Net Solutions; LathNet: www.mortarnet.com/#sle.
    b. Substitutions: See Section 01 60 00 - Product Requirements (Non-Wold Master - For Reference Only).

B. Casing Beads, Weep Screeds, and Joint Accessories as required.

C. Water-Resistive Barrier: ASTM D226/D226M or ASTM E2556/E2556M.

D. For Metal Framing: Corrosion-resistant, No. 8 self-tapping metal screws; length as necessary to penetrate 3/8 inch (9.525 mm) through metal studs.

E. Lightweight Synthetic Stone Veneer Adhesive: Single-component medium-modulus elastomeric adhesive acceptable to manufacturer for interior installations.

F. Flashings: See Section 04 20 00.

G. Bonding Compound: Provide type recommended for bonding scratch coat to solid surfaces, complying with ASTM C932.

H. Cleaning Solution: Non-acidic, not harmful to AMSMV work or adjacent materials, approved by AMSMV manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that backup wall system construction complies with AMSMV manufacturer's instructions, NCMA (AMSV), NCMA TEK 20-01, ASTM C1780 and ICC-ES AC51.

B. Verify that substrates to receive mortar scratch coat or setting bed comply with AMSMV manufacturer's instructions, NCMA (AMSV), NCMA TEK 20-01, ASTM C1780 and ICC-ES AC51:
1. Concrete Masonry: Verify joints are cut flush and surface is ready to receive mortar setting bed. Verify no bituminous or water repellent coatings exist on masonry surface.
2. Concrete: Verify surfaces are flat, honeycomb is filled flush, and surface is ready to receive mortar setting bed. Verify no bituminous, water repellent, or form release agents exist on concrete surface that are detrimental to mortar setting bed.
3. Metal Lath and Accessories: Verify lath is flat, secured to substrate, and joint and surface perimeter accessories are in place.

C. Verify that related items provided under other sections are properly sized and located.

D. Verify that built-in items are in proper location, and ready for installation of AMSMV.

3.02 PREPARATION

A. Dampen masonry surfaces to reduce excessive suction.

B. Clean concrete surfaces of foreign matter using approved acid solutions, solvents, or detergents, and then rinse surfaces thoroughly with clean water.

C. Roughen smooth concrete surfaces and apply bonding compound in accordance with manufacturer's written installation instructions.

D. Apply dash bond coat to solid bases and moist cure for at least 24 hours before applying setting bed.

3.03 INSTALLATION - WATER-RESISTIVE BARRIER

A. Where required by AMSMV manufacturer's instructions, NCMA (AMSV), NCMA TEK 20-01, ASTM C1780 or ICC-ES AC51, install 2 layers of water-resistive barrier in accordance with water-resistive barrier manufacturer's instructions. Integrate water-resistive barrier with all flashing accessories, adjacent water-resistive barriers, doors, windows, penetrations, and cladding transitions.

B. Apply water-resistive barrier horizontally with upper layer lapped over lower layer minimum 2 inches (51 mm).

C. Lap water-resistive barrier minimum 6 inches (152 mm) at vertical joints.

D. Lap water-resistive barrier minimum 16 inches (406 mm) past the corner in both directions at inside and outside corners.

E. In two layer applications, start with two horizontal layers at bottom of exterior wall or structure.

3.04 INSTALLATION - RAINSCREEN DRAINAGE MATERIAL

A. Install rainscreen drainage material and metal lath with accessories over sheathing material and water-resistive barrier with fastening system in accordance with ASTM C1063 into wood or metal studs. Install drainage material with filter fabric mortar screen to exterior.

B. Install metal lath with rainscreen drainage material in accordance with the manufacturer's instructions.

3.05 INSTALLATION - SCRATCH COAT

A. Apply mortar scratch coat of 1/2 inch (12.5 mm) nominal to cover metal lath in accordance with ASTM C926. Scratch surface when somewhat firm. If scratch coat dries before applying setting bed mortar and AMSMV, moisten scratch coat by misting it with water.

3.06 INSTALLATION - AMSMV

A. Install AMSMV with a cementitious mortar setting bed to a scratch coat backing surface, in accordance with AMSMV manufacturer's instructions, NCMA (AMSV), NCMA TEK 20-01, ASTM C1780 and ICC-ES AC51.

B. Mortar Joints: Concave.

1. Style: Tight fit joints.

C. Sills: Install sills where located on drawings.

D. Caps: Install capstones where located on drawings.

E. Seal all joints at wall openings and penetrations with sealant approved for use with AMSMV.

3.07 INSTALLATION - MASONRY FLASHINGS

A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

B. Extend metal flashings through exterior face of AMSMV and terminate in an angled drip with hemmed edge.

C. Extend plastic flashings to within 1/2 inch (12 mm) of exterior face of AMSMV and adhere to top of stainless steel angled drip with hemmed edge.

D. Lap end joints of flashings at least 6 inches (152 mm), minimum, and seal watertight with flashing sealant/adhesive.

3.08 CONTROL AND EXPANSION JOINTS

A. Form joints as detailed on drawings.

3.09 TOLERANCES

A. Maximum Variation from Unit to Adjacent Unit: 1/16 inch (1.6 mm).

B. Maximum Variation from Plane of Wall: 1/4 inch in 10 feet (6 mm in 3 m) and 1/2 inch in 20 feet (13 mm in 6 m) or more.

C. Maximum Variation from Plumb: 1/4 inch (6 mm) per story non-cumulative; 1/2 inch (13 mm) in two stories or more.

D. Maximum Variation from Level Coursing: 1/8 inch in 3 feet (3 mm in 1 m) and 1/4 inch in 10 feet (6 mm in 3 m); 1/2 inch in 30 feet (13 mm in 9 m).

E. Maximum Variation of Joint Thickness: 1/8 inch in 3 feet (3 mm in 1 m).

3.10 CUTTING AND FITTING

A. Cut and fit for pipes and conduit. Coordinate with other sections of work to provide correct size, shape, and location.

3.11 CLEANING

A. Remove excess mortar and mortar smears as work progresses.

B. Replace defective mortar. Match adjacent work.

C. Clean AMSMV in accordance with manufacturer's installation instructions.

D. Clean soiled surfaces with cleaning solution.

E. Use non-metallic tools in cleaning operations.

3.12 PROTECTION

A. Protect finished work from rain during and for 48 hours following installation.

B. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 04 73 00

SECTION 05 31 00
STEEL DECKING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Details of Construction, and General Provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

A. Roof deck.
B. Steel Deck:
   1. Steel deck will not be fireproofed.

1.03 RELATED REQUIREMENTS

A. Section 01 45 33 - Structural Testing and Special Inspection
B. Section 05 12 00 - Structural Steel Framing: Support framing for openings larger the 6 inches.

1.04 REFERENCE STANDARDS

A. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2024.
B. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
C. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2018, with Errata (2022).
D. SDI (RD) - Specifications and Commentary for Steel Roof Deck; 2017
E. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.

1.05 SUBMITTALS

A. See Division 1 for submittals procedures.
B. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.
C. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.
   1. If shop drawings are resubmitted after the original review, identify all changes made to the shop drawings after the original submittal with clouds or similar markings.
D. Welders' Qualification Statement: Submit to Special Inspector welders' qualifications in accordance with AWS B2.1/B2.1M.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this Section with minimum 3 years of experience.
B. Codes and Standards: Comply with the provisions of the following, except as otherwise indicated:
   1. SDI, "Specifications and Commentary for Steel Roof Deck"
   2. AWS D1.3, "Structural Welding Code - Sheet Steel"
C. Provide personnel qualified according to AWS D1.3 for all shop and field welding.
D. Manufacturer shall be a member of the Steel Deck Institute.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Cut plastic wrap to encourage ventilation.
B. Store deck on dry wood sleepers; slope for positive drainage. Protect with a waterproof covering ventilated to avoid condensation.
C. Deliver, unload, store and erect deck in a manner to completely protect the deck from damage.

1.08 PROJECT SITE CONDITIONS

A. Verify all dimensions given on the Drawings and make such field measurements as are necessary to lay out the work properly and assure proper fit and proper elevations. Be fully responsible for accuracy of all measurements and laying out of the work.

PART 2 PRODUCTS

2.01 STEEL DECK

A. Roof Deck: Non-composite type, fluted steel sheet:
   1. Ungalvanized Steel Sheet: ASTM A1008/A1008M, Designation SS, Grade 40, Type 1.
   2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
      a. Deck to be fireproofed: Left unpainted on the side to be fireproofed or painted with a primer compatible with the fireproofing to achieve the required UL rating.
   3. Minimum Base Metal Thickness: As indicated on the drawings.
   4. Nominal Height: 1-1/2 inch.
      a. Profile: Fluted; SDI WR.
      b. Formed Sheet Width: 36 inch.
      c. Structural Properties: Meet or exceed Vulcraft type Vulcraft Type 1.5B
         1) Span Design: Multiple.
   5. Side Joints: Fastened per drawings.
   6. End Joints: Fastened per drawings.

2.02 ACCESSORY MATERIALS

A. Welding Materials: AWS D1.1 and D1.3, E70xx electrodes.
B. Power Driven Fasteners: Hilti X-HSN24 for bar joists 1/8" to 3/8" thick, X-ENP for structural steel greater than 1/4" thick.
C. Screw Fasteners: Galvanized hardened steel, self tapping, TEKS.
D. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.03 FABRICATED DECK ACCESSORIES

A. Sheet Metal Deck Accessories:
   1. Metal closure strips: 20 gage, 0.0359 inch thick sheet steel; of profile and size as indicated on drawings; finished same as deck.
   2. Metal cover plates: gage and finish same as deck.

2.04 FABRICATION

A. Fabricate in accordance with SDI Specifications.
B. Fabricate deck to span over a minimum of 3 supports wherever possible.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions prior to beginning work.

3.02 INSTALLATION

A. Erect metal deck in accordance with SDI Specifications and manufacturer's instructions. Align and level.
B. Fasten deck in accordance with deck fastening detail shown on drawings or manufacturer's standard requirements, whichever is greater.
C. Weld deck in accordance with AWS D1.3. Do not weld when temperature is below 0 degrees F. Protect metal being welded from rain and snow.
D. Where deck (other than cellular deck electrical raceway) changes direction, install 6 inch minimum wide sheet steel cover plates, of same thickness as deck. Fusion weld 12 inches on center maximum.
E. At openings between deck and walls, columns, and openings, provide sheet steel closures and angle flashings to close openings.
F. Immediately after welding deck and other metal components in position, clean welds and coat welds, burned areas, and damaged surface coating, with touch-up primer after inspections are completed.
G. Install deck with major flat surface on top (normal position).
H. Protect the completed deck from construction loads in excess of 30 psf. Move all loads across the deck on wood planking (or similar means) to distribute loads.

3.03 FIELD QUALITY CONTROL

A. Structural Testing and Special Inspection

1. Structural Special Inspection shall be performed by qualified parties as specified herein, and in accordance with the provision of Section 01 45 33.
2. Definitions:
   a. ASNT - American Society for Non-Destructive Testing
   b. CAWI - American Welding Society Certified Associate Weld Inspector
   c. CWI - American Welding Society Certified Weld Inspector
3. Personnel Qualifications
   a. Special Inspector Technical II: CAWI with minimum 3 years experience or ASNT Level II, employed by a testing agency and supervised by a CWI or ASNT Level III with a minimum of 10 years experience.
   b. Individuals performing welding inspection must be AWS certified.
4. The Owner will provide the following tests and inspections. Qualifications: Technical II
   a. Verify qualifications of welders prior to the start of welding.
   b. Observe welding procedures at the start of welding. Verify that appropriate welds are being obtained.
   c. Verify quality, size, location, and spacing of all welds and mechanical fasteners.

END OF SECTION 05 31 00

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Section includes: All labor, material necessary to complete all items of miscellaneous metal as listed on the schedule in Part 2 and shown on the Drawings.

B. The design, fabrication, transportation to the project site, and associated operations required to complete miscellaneous metals, including all the various metal items manufactured to more or less standard details in sizes conforming to specific requirements of the project.

C. Shop fabricated steel, aluminum, and galvanized and stainless steel items.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
2. Design data: Submit drawings and supporting calculations, signed and sealed by a licensed professional structural engineer (PE) in the State the project is located.
    a. Metal railings, stairs, ladders, and other items specified in this section shall be designed to resist self-weight and the more stringent of:
        1) Superimposed Dead and Live Loads indicated on the Contract Documents, and
        2) Loads set forth by the governing Building Code.
    b. The maximum Live Load deflection shall be L/360. Deflection determined based on structural section(s) alone
3. Coordinate work with other suppliers and subcontractors; obtain their approved shop drawing where necessary, or obtain any necessary additional detail information regarding mounting conditions or other aspects of related work.

1.03 QUALITY ASSURANCE

A. Design under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.

B. Plates: ASTM A283/A283M.

C. Stainless Steel, General: ASTM A666, Type 304 or 302.

D. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.

E. Expansion and Adhesive Anchors:

1. Wedge Anchors: Hilti "Kwik Bolt II" or Ramset/Redhead "Trubolt" or equal.
2. Heavy Duty Sleeve Anchors: Hilti "HSL" or equal.
3. Adhesive Anchors: Hilti "HVA" or "HIT", Ramset/Redhead "EPCON" or equal.

F. Bolts, Nuts, and Washers: Appropriate for the materials being connected.

G. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

I. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 MATERIALS - ALUMINUM

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.

B. Sheet Aluminum: ASTM B209/B209M, 5052 alloy, H32 or H22 temper.

C. Bolts, Nuts, and Washers: Stainless steel.

D. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

2.03 FABRICATION

A. Take field measurements before fabrication when required.
B. Fit and shop assemble items in largest practical sections, for delivery to site.
C. Fabricate items with joints tightly fitted and secured.
D. Continuously seal joined members exposed in the work by continuous welds and grinding smooth.
E. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
H. In all areas of exposed steel that is to receive a finish:
    1. Piece marks hidden: Fabricate such that piece marks are fully hidden in the final structure or made with such media to permit full removal after erection.
    2. Mill mark removal: Deliver steel with no mill marks (stenciled, stamped, raised, etc) in exposed locations. Omit mill marks by cutting of mill material to appropriate lengths where possible. Where not possible, fill and/or grind to a surface finish consistent with the adjacent material.

2.04 SCHEDULE OF FABRICATED ITEMS

A. Items listed in this Section are intended only as a guide, but do not relieve responsibility for verifying quantities and inclusion of all similar items. Thoroughly examine all Drawings for items of miscellaneous metal fabrications.
    1. Ships ladders.
B. Other miscellaneous metal items shown on drawings.

2.05 FINISHES - STEEL

A. Prime paint steel items.
    1. Exceptions: Galvanize items to be embedded in concrete and items to be embedded in masonry.
    2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
    3. Do not paint aluminum or stainless steel items, unless specifically called for on the drawings.
B. Prepare surfaces in non-public areas to be primed in accordance with SSPC-SP2.
C. Prepare surfaces in public areas to be primed in accordance with SSPC-SP6.
D. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
E. Prime Painting: One coat.
F. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements for all steel items exposed to weather.
G. Slotted Channel Framing: ASTM A653/A653M, Grade 33.
H. Stainless Steel Finish: #4 Satin, ASTM A167.

2.06 FINISHES - ALUMINUM

A. Interior Aluminum Surfaces: Class I natural anodized.
B. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.
C. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.07 FABRICATION TOLERANCES

A. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.
B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).
C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).
D. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
E. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Furnish setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Field weld components as indicated on shop drawings.

D. Perform field welding in accordance with AWS D1.1/D1.1M.

1. Continuously weld field splices and grind smooth where exposed to view.
2. Fill exposed splice joints with body filler and sand smooth

E. Obtain approval prior to site cutting or making adjustments not scheduled.

F. After erection, prime welds, abrasions, and surfaces not shop primed , except surfaces to be in contact with concrete.

G. After erection, touch-up damaged hot dipped galvanizing.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

C. Maximum Out-of-Position: 1/4 inch (6 mm).

3.05 FIELD QUALITY CONTROL

A. Structural Testing and Special Inspection

1. Comply with the requirements of Section 05 10 00 – Structural Steel Framing
2. The Owner will employ a Special Inspector for the following:
   a. Visual inspect 100% of all fillet welds, for size, length, and quality, per AWS D1.1. Qualifications: Technical II.

END OF SECTION 05 50 00

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Details of Construction, and General Provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

A. Structural dimension lumber framing and engineered wood products.
B. Sheathing.
C. Preservative treated wood materials.

1.03 RELATED REQUIREMENTS

A. Section 03 15 10 - Post-Installed Anchors.
B. Section 06 10 53 - Miscellaneous Rough Carpentry.
C. Section 07 25 00 - Weather Barriers: Water-resistive barrier over sheathing.
D. Section 07 62 00 - Sheet Metal Flashing and Trim: Sill flashings.
E. Section 09 21 16 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.04 REFERENCE STANDARDS

A. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
C. ANSI/ASME Standard B18.6.1 - Wood Screws (Inch Series); 1981.
D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
E. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
G. ASTM D5456 - Standard Specification for Evaluation of Structural Composite Lumber Products; 2021, with Editorial Revision.
H. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples; 2021.
I. AWPA U1 - Use Category System: User Specification for Treated Wood; 2025.
J. PS 1 - Structural Plywood; 2023.
K. PS 2 - Performance Standard for Wood Structural Panels; 2019.
L. PS 20 - American Softwood Lumber Standard; 2025.

1.05 SUBMITTALS

A. See Division 1 for submittal procedures.
B. Product Data: Provide technical data on wood preservative materials, metal framing connectors, laminated veneer lumber, and parallel strand lumber.
C. Panelized stud walls shop drawings: If panelized walls are used, submit layout drawings of panels in plan and elevation of each wall panel indicating all members and dimensions. Include size, species, and grade of each member. If sheathing is shop applied, indicate sheathing type, thickness, and fastening information.
    1. If shop drawings are resubmitted after the original review, identify all changes made to the shop drawings after the original submittal with clouds or similar markings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. Species as indicated below for each use.
   2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

B. Lumber fabricated from old growth timber is not permitted.

2.02 DIMENSION LUMBER

A. Sizes: Nominal sizes as indicated on drawings, S4S.

B. Moisture Content: S-dry or MC19.

C. Stud Framing (2x) used in a vertical position in bearing walls:
   1. Species and Grade: as indicated on drawings.

D. Joist, Rafter, and Small Beam Framing (2x6 through 4x16):
   1. Species and Grades: As indicated on drawings.

E. Preservative Treated Subsill Plates:
   1. Species: Southern Pine.
   2. Grade: No. 2.

2.03 ENGINEERED WOOD PRODUCTS

A. Laminated Veneer Lumber (LVL): Laminated veneer lumber with structural capacities established and monitored in accordance with ASTM D5456. Parallel Strand Lumber (PSL) with matching or better properties may be substituted.
   1. Acceptable manufacturers include Weyerhauser, Boise Cascade, Louisiana-Pacific, Georgia-Pacific, Willamette Industries, and RedBuilt.
   2. Minimum design properties: As indicated on drawings.

B. Parallel Strand Lumber (PSL):
   1. Acceptable manufacturers include: Trus Joist
   2. Minimum design properties: As indicated on drawings.

2.04 CONSTRUCTION PANELS

A. Roof Sheathing, for patching as needed: PS 1 or PS 2; APA rated Sheathing.
   1. Exposure Class: Exposure 1.
   2. Span Rating: 40/20.
   3. Thickness: 5/8 inch, nominal, minimum. Match existing thickness.
   4. Edges: Square.

B. Wall Sheathing: See Section 09 21 16.

2.05 ACCESSORIES

A. Fasteners and Anchors:
   1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M or stainless steel for high humidity and treated wood locations and to match finish on metal connectors, unfinished steel elsewhere.
   2. Nails: ASTM F1667, common wire nails, unless otherwise specified.
   3. Bolts: ASTM A307 .
   4. Lag Screws: ASME B18.2.1.
   5. Wood Screws: ANSI/ASME Standard B18.6.1.

B. Post-installed anchors: See Section 03 15 10.

C. Metal Framing Connectors: Includes hangers, post bases, post caps, tension ties, hold-downs, and framing angles. Hot dipped galvanized steel, sized to suit framing conditions.
   1. Drawings show Simpson Strong-Tie products. Alternate products shall have equal or greater strength.

2. All products to have current ICC approval.
3. For contact with treated wood, provide minimum G185 galvanizing per ASTM A653/A653M, hot-dipped galvanizing per ASTM A123/A123M, or stainless steel, grade 316L.

D. Sill Gasket on Top of Foundation Wall: 1/4 inch thick, closed-cell plastic foam.
1. Width: Match plate width.

E. Sill Flashing: See Section 07 62 00.

F. Water-Resistive Barrier: See Section 07 25 00.

2.06 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
1. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Preservative Pressure Treatment of Lumber Above Grade: AWPA, Use Category UC3B, Commodity Specification Ausing waterborne preservative to 0.25 lb/cu ft retention.
1. Treat lumber exposed to weather.
2. Treat lumber in contact with roofing, flashing, or waterproofing.
3. Treat lumber in contact with masonry or concrete.
4. Treat lumber less than 18 inches above grade.
5. Treat lumber in other locations as indicated.

C. Preservative Pressure Treatment of Plywood Above Grade: AWPA, Use Category UC2 and UC3B, Commodity Specification Fusing waterborne preservative to 0.25 lb/cu ft retention.
1. Treat plywood in contact with roofing, flashing, or waterproofing.
2. Treat plywood in contact with masonry or concrete.
3. Treat plywood less than 18 inches above grade.
4. Treat plywood in other locations as indicated.

D. Preservative Pressure Treatment of Lumber in Contact with Soil: AWPA, Use Category UC4A, Commodity Specification Ausing waterborne preservative to 0.4 lb/cu ft retention.
1. Preservative for Field Application to Cut Surfaces: As recommended by manufacturer of factory treatment chemicals for brush-application in the field.

2.07 SOURCE QUALITY CONTROL

A. Provide dimension lumber with each piece factory marked with grade stamp of an accredited grading agency identifying grade, species, and moisture content at time of surfacing.

B. Provide APA-rated panels with each piece factory marked with grade stamp of APA identifying type, exposure durability classification, span rating, and thickness.

C. Provide APA-rated rim boards and LVL with APA EWS trademark.

PART 3 EXECUTION

3.01 PREPARATION

A. Where wood framing bears on cementitious foundations, install full width sill flashing continuous over top of foundation, lap ends of flashing minimum of 4 inches and seal.

B. Install sill gasket under sill plate of framed walls bearing on foundations; puncture gasket cleanly to fit tightly around protruding anchor bolts.

C. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 FRAMING INSTALLATION

A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.

B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.

C. Install structural members full length without splices unless otherwise specifically detailed.

D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by AFPA Wood Frame Construction Manual and IBC Table 2304.10.1.

E. Strictly comply with manufacturer's installation instructions for product installation. Install all bolts and nails in metal framing connectors.

F. Install horizontal spanning members with crown edge up and not less than 1-1/2 inches of bearing at each end.

G. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.

H. Provide bridging at joists in excess of 8 feet span at mid-span. Fit solid blocking at ends of members.

I. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

3.04 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim. See Section 06 10 53 - Miscellaneous Rough Carpentry.

B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.

3.05 INSTALLATION OF CONSTRUCTION PANELS

A. General

1. Install sheathing with panel continuous over two or more spans.
2. Provide 1/8" space at ends and edges of panels unless otherwise indicated by the panel supplier.
3. Lay out wood structural panel sheathing to provide panel widths 24” or wider wherever possible. Where a panel width less than 24” is required, verify narrow-width panel is free of large knots, surface voids, and handling damage. Provide blocking (2x4 minimum) at unsupported edges for panels that are less than 24” wide and attach blocking to framing.

B. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.

1. Nail panels to framing; staples are not permitted.

3.06 SITE APPLIED WOOD TREATMENT

A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.

B. Allow preservative to dry prior to erecting members.

3.07 TOLERANCES

A. Framing Members: 1/4 inch from true position, maximum.

B. Surface Flatness of Floor: 1/4 inch in 10 feet maximum, and 1/2 inch in 30 feet maximum.

C. Variation from Plane, Other than Floors: 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.08 CLEANING

A. After erection and attachment of lumber, remove clay, mud, or other foreign materials from all members.

B. Waste Disposal: Comply with the requirements of Section 01 74 19.

1. Comply with applicable regulations.

2. Do not burn scrap on project site.
3. Do not burn scraps that have been pressure treated.
4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.

C. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.

D. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 10 00

SECTION 06 10 53
ROUGH CARPENTRY-WOOD BLOCKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Miscellaneous blocking, sleepers and nailers, shown on Drawings or required.
B. Blocking within gypsum wallboard partitions for support of grab bars, toilet accessories, casework, hardware, other wall mounted specialties.
C. Exterior batt insulation within wood blocking at exterior windows.
D. Preservative treated wood materials.
E. Fire retardant treated wood materials.
F. Communications and electrical room mounting boards.
G. Concealed wood blocking, nailers, and supports.
H. Miscellaneous wood nailers, furring, and grounds.
I. Blocking for Owner furnished Furniture, Fixtures and Equipment when noted on the drawings.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide technical data on fire retardant treated and preservative treated lumber.

1.03 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. Species: Douglas Fir-Larch, Hem-Fir, or Southern Pine.
   2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
   3. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
B. Metal strapping is acceptable to substitute for wood blocking for cabinets/casework, as follows:
   1. 20 gauge flat strap and backing plate sheet.
   2. Width: 6 inch.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Provide preservative-treated lumber for work exposed to moisture or indirect contact with concrete slabs.
   1. Preservative-treated lumber is not required for blocking that is protected by roofing membrane, peel and stick flashing or weather barrier.
B. Provide fire-retardant lumber for all interior and exterior framing and blocking with exception as follows:
   1. Blocking concealed in walls is not required to be fire-retardant lumber in construction types Type I and Type II buildings as noted on the Code Plan.
   2. When blocking is 48” or less above the top of the structural roof deck, fire retardant lumber is not required in construction types Type I and Type II buildings as noted on the Code Plan.
C. Sizes: Nominal sizes as indicated on drawings, S4S.
D. Moisture Content: S-dry or MC19.
E. Blocking for sizes 2 by 2 through 2 by 6 (50 by 50 mm through 50 by 150 mm):
   1. Species: Douglas Fir-Larch, Hem-Fir or Southern Pine.
   2. Grade: No.2.
F. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
   1. Lumber: S4S, No.2 or Standard Grade.

2.03 CONSTRUCTION PANELS-BLOCKING

A. Electrical Room Mounting Boards: PS 1, A-D plywood, or medium density fiberboard; 3/4 inch (19 mm) thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

B. Communications Room Mounting Boards: PS 1, A-C plywood (void free), or medium density fiberboard; 3/4 inch (19 mm) thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

C. Plywood blocking:
   1. Meet APA C-D exterior, thickness as shown on Drawings.
   2. Provide preservative-treated lumber for work exposed to moisture or indirect contact with concrete slabs, as shown on drawings.
      a. Preservative-treated lumber is not required for blocking that is protected by roofing membrane, peel and stick flashing or weather barrier.
   3. Provide fire-retardant lumber for all interior and exterior blocking.
      a. Blocking concealed in walls is not required to be fire-retardant lumber in construction types Type I and Type II buildings as noted on the Code Plan.
      b. When blocking is 48” or less above the top of the structural roof deck, fire retardant lumber is not required in construction types Type I and Type II buildings as noted on the Code Plan.

2.04 ACCESSORIES

A. Fasteners and Anchors:
   1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
   2. Anchors: Toggle bolt type for anchorage to hollow masonry.

B. Die-Stamped Connectors: Hot dipped galvanized steel, sized to suit framing conditions.
   1. For contact with preservative treated wood in exposed locations, provide minimum G185 (Z550) galvanizing complying with ASTM A653/A653M.

C. Sill Sealer: 1/4 inch (6 mm) thick, plate width, closed cell plastic foam from continuous rolls.

D. Construction Adhesives: Adhesives complying with ASTM C557 or ASTM D3498.

E. Exterior Batt Insulation occurring with-in blocking of the exterior envelope: Refer to the requirements of Section 07 21 00 - Insulation.

2.05 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
   1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
   2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Preservative Treatment:
   1. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A, using waterborne preservative to 0.10 lb/cu ft retention (to 1.6 kg/cu m retention).
      a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
      b. Treat lumber exposed to weather.
      c. Treat lumber in contact with roofing, flashing, or waterproofing (Note: treated blocking is not required when covered with roofing material, peel and stick type flashing and weather barrier).
      d. Treat lumber in contact with masonry or concrete.

2. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative to 0.25 lb/cu ft retention (to 4.0 kg/cu m retention).
    a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
    b. Treat plywood in contact with roofing, flashing, or waterproofing (Note: treated blocking is not required when covered with roofing material, peel and stick type flashing or weather barrier).
    c. Treat plywood in contact with masonry or concrete.
    d. Treat plywood in other locations as indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate installation of rough carpentry members specified in other sections (obtain product data, sizes and anchorage requirements from other trades prior to installation) including, but not limited to:
    1. Roofing applications as specified in Divisions 7, 22 and 23.
    2. Windows, storefront and curtainwall in Division 8.
    3. Miscellaneous specialties in Division 10.
    4. Blocking for hardware in Section 08 71 00.
    5. Furniture fixtures and equipment items furnished by the Owner and noted on the drawings.

3.02 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.
B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
B. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
E. Provide the following specific nonstructural framing and blocking:
    1. Cabinets and shelf supports.
    2. Handrails.
    3. Grab bars.
    4. Towel and bath accessories.
    5. Wall mounted baby changing tables.
    6. Chalkboards and marker boards.
    7. Wall paneling and trim.
    8. Joints of rigid wall coverings that occur between studs.
    9. Door hardware.
    10. Blocking for wall mounted technology items, i.e. Smartboards, Promethean boards and/or TV's.
F. Install sill sealer where indicated on drawings, including at window sills.
G. Install exterior batt insulation with-in blocking as necessary to fill voids.

3.04 ROOF-RELATED CARPENTRY

A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.
B. Provide wood curb at roof openings except where prefabricated curbs are specified and where specifically indicated otherwise. Form corners by alternating lapping side members.

3.05 INSTALLATION OF CONSTRUCTION PANELS

A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on edges and into studs in field of board.
   1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
   2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
   3. Install adjacent boards without gaps.
   4. Size: 48 by 96 inches (2440 by 4880 mm).
   5. Coordinate with electrical/technology drawings and communications contractor on the requirements for installing panels.

3.06 CLEANING

A. Waste Disposal:
   1. Comply with applicable regulations.
   2. Do not burn scrap on project site.
   3. Do not burn scraps that have been pressure treated.
   4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.

C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 10 53

SECTION 06 16 43
GYPSUM SHEATHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Glass-mat faced gypsum sheathing.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   1. Product Data: Manufacturer's specifications and installation instructions for each product specified.

1.03 QUALITY ASSURANCE

A. Referenced Specifications: Current Gypsum Association Publications (www.gypsum.org).
B. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.04 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling
   1. Deliver materials to the project site with manufacturer's labels intact and legible.
   2. Handle materials with care to prevent damage.
   3. Deliver fire-rated materials bearing testing agency label and required fire classification numbers.
B. Storage
   1. Store materials under cover, stack flat, and off ground.

PART 2 PRODUCTS

2.01 GYPSUM SHEATHING

A. The following manufacturers/products are acceptable:
   1. Georgia-Pacific Gypsum LLC; DensGlass Gold Exterior Sheathing: www.gpgypsum.com.
   2. National Gypsum Company; Gold Bond Brande eXP Extended Exposure Gypsum Sheathing: www.nationalgypsum.com.
   3. USG Corporation; Securock Glass Mat Gymsum Sheathing: www.usg.com.
   4. Certain Teed Corporation; GlasRoc Sheathing: www.certainteed.com.
B. Panel Physical Characteristics
   1. Core: Regular gypsum core (Type X gypsum core at fire rated conditions) with additives to enhance moisture and mold resistance.
   2. Facing: Water-resistant glass mat on both face, back, and long edges.
   3. Overall thickness: 5/8 inch (15.875 mm).
   4. Panel complies with requirements of ASTM C 1177 (ASTM C1177, Type X at fire rated conditions).
   5. Racking strength – Ultimate: 540 lbs/sq.ft. (25.85534 kPa) dry when tested in accordance with ASTM E72.
   6. Flexible Strength – Parallel: 80 lbs (36.2874 mm), when tested in accordance with ASTM C473.
   7. Humidified Deflection: Not more than ¼ inch when tested in accordance with ASTM C473.
   8. Nail Pull Resistance: 80 lbs, when tested in accordance with ASTM C473.
   9. Water Absorption: Less than 10% when tested in accordance with ASTM C473.
   10. Surface Water Absorption: Less than 1% when tested in accordance with ASTM C473.
   11. Permeance: Greater than 10 perms (6.590 metric perms), when tested in accordance with ASTM E96.
   12. R-Value: 0.40 (2.5 K) when tested in accordance with ASTM C518.
   13. Combustibility: Noncombustible when tested in accordance with ASTM E136.
   14. Flame spreads/smoke developed: 5/0 when tested in accordance with ASTM E84.
   15. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273.

2.02 ACCESSORIES

A. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating have a salt-spray resistance of more than 800 hours according to ASTM B 117.
   1. For steel framing less than 0.0329 inch (0.83566 mm) thick, attach sheathing to comply with ASTM C 1002.
   2. For steel framing from 0.033 to 0.112 inch (0.8382 to 2.8448 mm) thick, attach sheathing to comply with ASTM C 954.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspection: Verify that project conditions and substrates are acceptable, to the installer, to begin installation of work of this section.

3.02 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to cold-formed metal framing with screws.
   2. Install boards with a 3/8 inch gap where non-load-bearing construction abuts structural elements.
   3. Install boards with a ¼ inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach board at perimeter and within field of board to each steel stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

D. Vertical installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

END OF SECTION 06 16 43

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specially fabricated cabinet units.
   1. Plastic Laminate.
B. Standing and running trim.
C. Countertops.
D. Window stools/sills.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Scale of Drawings: 1-1/2 inch to 1 foot (125 mm to 1 m), minimum.
C. Product Data: Provide data for hardware accessories.
D. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches (300 mm) square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.
E. Samples: Submit actual sample items of proposed pulls, hinges, shelf standards, and locksets, demonstrating hardware design, quality, and finish.

1.03 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum ten years of documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect units from moisture damage.

1.05 FIELD CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Single Source Responsibility: Provide and install this work from single fabricator.

2.02 CABINETS

A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
B. Plastic Laminate Faced Cabinets: Custom grade.
   1. Cabinets as noted on the drawings:
      a. Finish - Exposed Exterior Surfaces: Decorative laminate.
      b. Finish - Exposed Interior Surfaces: Decorative laminate.
      c. Finish - Semi-Exposed Surfaces: Decorative laminate
      d. Finish - Concealed Surfaces: Manufacturer's option.
      e. Door and Drawer Front Edge Profiles: Square edge with PVC banding..
      f. Door and Drawer Front Retention Profiles: Fixed panel.
      g. Casework Construction Type: Type B - Face-frame.
         1) Interface Style for Cabinet and Door: Style 1 - Overlay; flush overlay.
      h. Adjustable Shelf Loading: 40 psf (19.5 gm/sq cm).
         1) Deflection: L/144.
      i. Cabinet Style: Flush overlay.
      j. Cabinet Doors and Drawer Fronts: Flush style.

2.03 STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Quality Standard: Comply with AWI Section 500.
B. Grade: Premium.

C. Lumber Species: See Interior Material/Finish Color Schedule, on the Drawings.
D. Locations: At sliding barn door valance, trim over Hollow Metal Door Frames, chair rail, handrail backerboard trim.

2.04 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

2.05 PANEL CORE MATERIALS

A. Particleboard: Composite panel composed of cellulosic particles, additives, and bonding system; comply with ANSI A208.1.
   1. Grade: M-2; moisture resistance: MR10.
B. Medium Density Fiberboard (MDF): Composite panel composed of cellulosic fibers, additives, and bonding system; cured under heat and pressure; comply with ANSI A208.2.
   1. Grade: 115; moisture resistance: MR10.
C. Basic Hardboard: Panel manufactured from inter-felted lignocellulosic fibers consolidated under heat and pressure; comply with ANSI A135.4.
   1. Class: Tempered.
   2. Surface: Smooth one side (S1S).

2.06 LAMINATE MATERIALS

A. Plastic Laminate: High Pressure Decorative Laminate (HPDL): NEMA LD 3, as follows:
   1. High-pressure decorative laminate VGS (.028), NEMA Test LD 3-2005.
   2. High-pressure decorative laminate HGS (.048), NEMA Test LD 3-2005.
   3. High-pressure decorative laminate HGP (.039), NEMA Test LD 3-2005.
   4. High-pressure cabinet liner CLS (.020), NEMA Test LD 3-2005.
   5. High-pressure backer BKH (.048), (.039), (.028), NEMA Test LD3-2005.
   6. Colors/Textures: See Interior Material Finish/Color Schedule on the Drawings.
      a. Manufacturer as listed on the Interior Material Finish Schedule.
B. Provide specific types as indicated.
   1. Horizontal Surfaces: HGS, 0.048 inch (1.22 mm) nominal thickness, through color.
   2. Vertical Surfaces: VGS, 0.028 inch (0.71 mm) nominal thickness, through color.
   3. Post-Formed Horizontal Surfaces: HGP, 0.039 inch (1.0 mm) nominal thickness, through color.
   4. Post-Formed Vertical Surfaces: VGP, 0.028 inch (0.71 mm) nominal thickness, through color, finish as indicated.
   5. Cabinet Liner: CLS, 0.020 inch (0.51 mm) nominal thickness, through color, finish as indicated.

2.07 COUNTERTOPS

A. Solid Surfacing Countertops: Solid surfacing sheet over continuous substrate of plywood.
   1. Configuration for exposed edges, back and end splashes, with details indicated on drawings.
   2. Fabricate in accordance with manufacturer's standard requirements.
   3. All countertop joints must be dry fit at the factory to check for consistency in color from one panel to the other and overall finished panel thickness, resulting in a high quality product easy to install.
   4. Colors:
      a. See Interior Material Finish/Color Schedule on the Drawings.
      b. Manufacturer as listed on the Interior Material Finish Schedule.

2.08 WINDOW STOOLS/SILLS

A. Solid Surfacing: Solid surfacing sheet over continuous substrate of plywood.
   1. 1-1/8 inch (28.575 mm) thick unless noted different on the drawings.
   2. For stools/sills over 7 feet (2.1336 m) in length, provide expansion joint with color match polyurethane or silicone sealant and backer rod at maximum of 8 foot (2.438 m) o.c.
      a. Submit shop drawings that identify each stool/sill and locate expansion joint for review by Architect.

3. Colors:
    a. See Interior Material Finish/Color Schedule on the Drawings.
    b. Manufacturer as listed on the Interior Material Finish Schedule.

2.09 ACCESSORIES

A. Adhesive: Type recommended by fabricator to suit application.
B. Plastic Edge Banding for Plastic Laminate: Extruded PVC, flat or convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
    1. Plastic-Laminate Countertops, backsplashes, open shelving, cabinet doors and drawers:
        a. 3MM PVC.
        b. Color: See Interior Material Finish/Color Schedule, on Drawings.
    2. Cabinet body and shelf/shelving edges:
    3. 1 MM.
        a. Color matched to drawer/door/shelf face.
C. Fasteners: Size and type to suit application.
D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
E. Concealed Joint Fasteners: Threaded steel.
F. Grommets: Standard plastic grommets for cut-outs, in color to match adjacent surface.

2.10 HARDWARE

A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
B. Metal Z-Shaped Wall Panel Support Clips: Paired, cleated, structural anchorage components applied to paneling for mounting.
    1. Material: Extruded Aluminum.
    2. Size as required for applications.
C. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch (25 mm) spacing adjustments.
D. Countertop Support Brackets: Fixed, L-shaped, face-of-wall mounting.
    1. Materials: Steel; T-shape cross-section.
        a. Finish: Manufacturer's standard, factory-applied, powder coat.
        b. Color: Black.
    2. Products:
        a. A&M Hardware, Inc; Hybrid Brackets: www.aandmhardware.com/#sle.
        b. A&M Hardware, Inc; Heavy-Duty Hybrid Brackets: www.aandmhardware.com or equal.
        c. Substitutions: See Section 01 60 00 - Product Requirements (Non-Wold Master - For Reference Only).
E. Accessible-Compliant Vanity and Countertop Brackets:
    1. Material and Shape: Steel; formed compound shapes.
        a. Finish: Manufacturer's standard, factory-applied, textured powder coat.
        b. Color: Black.
    2. Height: 22 inches (560 mm) or per drawings.
    3. Products:
        a. A&M Hardware, Inc; ADA Vanity Brackets: www.aandmhardware.com or equal.
F. Concealed Countertop and Shelf Brackets: Fixed, concealed vertical leg, side-of-stud mounting.
    1. Materials: Steel L- and T-shapes.
        a. Finish: Manufacturer's standard, factory-applied, powder coat.
        b. Color: Black.
        c. Size: Varies - refer to drawings

2. Products:
    a. A&M Hardware, Inc; Concealed Brackets: www.aandmhardware.com/#sle.
    b. A&M Hardware, Inc; Concealed Flat Brackets: www.aandmhardware.com/#sle.
    c. Rakks/Rangine Corporation; Inside Wall Flush Mount Brackets: www.rakks.com/#sle.
    d. Rakks/Rangine Corporation; Sill Support Bracket at Resident Room Picture Shelf
        1) 4" x 6"
        2) Finish: Unfinished
        3) Other manufacturers are acceptable as approved by Architect.
    e. Substitutions: See Section 01 60 00 - Product Requirements (Non-Wold Master - For Reference Only).

G. Drawer and Door Pulls: See Interior Material Finish/Color Schedule on the Drawings..

H. Cabinet Locks: Grade 1, keyed cylinder, two keys per lock, master keyed, steel with satin finish.

I. Cabinet Nurse Server Push-to-close/turn-to-open latch:
    1. Manufacturer: Southco
        a. M1-2A-13-5 push-to-close latch (non-locking)
        b. M1-2A-23-5 push-to-close latch (locking)
    2. Finish: Black.

J. Drawer Slides:
    1. Type: Extension types as indicated.
    2. Static Load Capacity: Heavy Duty grade.
    3. Mounting: Side mounted.
    4. Stops: Integral type.
    5. Features: Provide self closing/stay closed type.
    6. Manufacturers:
        a. Accuride International, Inc; Heavy-Duty Drawer Slides: www.accuride.com or equal.
        b. Knape & Vogt Manufacturing Company; Heavy-Duty Drawer Slides: www.knapeandvogt.com.
        c. Sugatsune America, Inc: www.sugatsune.com/#sle.
        d. Substitutions: See Section 01 60 00 - Product Requirements (Non-Wold Master - For Reference Only).

K. Hinges: European style concealed self-closing type, steel with nickel-plated finish.
    1. Manufacturers:
        a. Blum, Inc: www.blum.com or equal.
        b. Substitutions: See Section 01 60 00 - Product Requirements (Non-Wold Master - For Reference Only).

2.11 SHOP TREATMENT OF WOOD MATERIALS

A. Provide UL (DIR) listed and approved identification on fire retardant treated material.

B. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.

2.12 SITE FINISHING MATERIALS

A. Finishing: Field finished, see Section 09 90 00.

2.13 FABRICATION

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs. (Locate counter butt joints minimum 600 mm from sink cut-outs.)
   1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
   2. Cap exposed plastic laminate finish edges with plastic trim.

E. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

2.14 SHOP FINISHING

A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

C. Use fixture attachments in concealed locations for wall mounted components.

D. Use concealed joint fasteners to align and secure adjoining cabinet units.

E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim for this purpose.

F. Secure cabinets to floor using appropriate angles and anchorages.

G. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 ADJUSTING

A. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 06 41 00

SECTION 07 05 53
FIRE AND SMOKE ASSEMBLY IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Identification markings for rated partitions noted on the Code Plan.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's printed product literature for each type of marking, indicating font, foreground and background colors, wording, and overall dimensions.

C. Schedule: Completely define scope of proposed marking, and indicate location of affected walls and partitions, and number of markings.

1.03 FIELD CONDITIONS

A. Do not install adhered markings when ambient temperature is lower than recommended by label or sign manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Partition Identification Labels:

1. Fire Wall Signs, Inc: www.firewallsigns.com.
2. Safety Supply Warehouse, Inc: www.safetysupplywarehouse.com.
3. Other manufacturers who meet the specification are acceptable.

2.02 FIRE AND SMOKE ASSEMBLY IDENTIFICATION

A. Regulatory Requirements: Comply with "Marking and Identification" requirements of "Fire-Resistance Ratings and Fire Tests" chapter of 703.7 of MN State Building Code.

1. Lettering to be not less than 3 inches (76 mm) in height with a minimum 3/8 inch (9.5 mm) stroke in a contrasting color incorportaing the rating of the wall noted on the Code Plan, i.e.: "FIRE AND/OR SMOKE BARRIER—PROTECT ALL OPENINGS".

B. Adhered Fire and Smoke Assembly Identification Signs: Printed vinyl signs with factory applied adhesive backing.

C. Languages: Provide sign markings in English.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

A. Locate labels as required by 703.7 of MN State Building Code and at a minimum of within 15 feet at the end of each wall or corner and a maximum of 30 feet on center, both sides of partitions, above accessible ceiling line or below access floors. Provide at least one label per wall face.

1. Place above access panels at hard lid ceilings.

B. Install adhered markings in accordance with manufacturer's instructions.

C. Install neatly, with horizontal edges level.

D. Protect from damage until Date of Substantial Completion; repair or replace damaged markings.

END OF SECTION 07 05 53

SECTION 07 21 00
INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sound batt insulation used to control sound transfer in stud wall construction.
B. Expanding foam insulation.
C. Vapor barriers used under slab.
D. Vapor barriers used in combination with batt insulation in walls.
E. Vapor barriers used in combination with insulated attics.
F. Building wrap used primarily over wood exterior sheathing.
G. Exterior batt insulation occurring in exterior envelope.
H. Roof insulation (base and tapered) for flat roofs, installed in two layers with staggered seams to create a vapor barrier.
I. Nailable roof insulation for sloped roofs, installed with staggered seams over a 1 inch (25.4 mm) base layer of roof insulation to create a vapor barrier.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on product characteristics, performance criteria, and product limitations for all specified products.
    1. For vapor barriers specifically provide:
        a. Manufacturer’s product samples and literature.
        b. Manufacturer’s installation instructions for placement, seaming and pipe boot installation.
    2. For Acoustic Spray System specifically provide:
        a. Installation data including application thickness of applied product.
C. Shop Drawings:
    1. Provide details of continuous semi rigid wall insulation and clip/sub-framing attachment.
    2. Drawings stamped by a Professional Engineer in the State the project is located that includes design of structural performance of clip and sub-framing anchorage, allowing for thermal loading and loading of components in accordance with applicable codes and regulations.

1.03 FIELD CONDITIONS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.
B. Deliver material to the site in unopened packages, with identification labels intact.
C. Store under water-resistant cover and protect from weather and direct sunlight.
D. Remove damaged materials from site.

PART 2 PRODUCTS

2.01 FOAM BOARD INSULATION MATERIALS

A. Extruded Polystyrene (XPS) Board Insulation: Complies with ASTM C578 with either natural skin or cut cell surfaces.
    1. Products:
        a. DuPont de Nemours, Inc; Styrofoam Brand Square Edge: building.dupont.com or equal.
    2. Cover at top of perimeter insulation: 0.125" painted or anodized aluminum sheet as detailed on drawings. Fasteners to be stainless or galvanized.
        a. Color: as selected from full standard range.
B. Roof Insulation (Base and Tapered):Polyisocyanurate (ISO) Board Insulation with Facers Both Sides: Rigid cellular foam, complying with ASTM C1289. Installed in a minimum of two staggered layers to create a vapor barrier.
    1. Classifications:
        a. Type II: Class 1-Faced with glass fiber mat facers on both major surfaces of the core foam.
            1) Class 1 - Faced with glass fiber reinforced cellulosic facers on both major surfaces of core foam.

2. Board Edges: Square.
3. Thermal Performance: Polyisocyanurate Long-Term Thermal Resistance Value of 5.7 per inch.
    a. Total thickness for base layer as noted on drawing.

2.02 MINERAL FIBER BLANKET INSULATION MATERIALS

A. Sound Batt Insulation: Mineral Fiber Batt Insulation, Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665, type 1; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84. Fiberglass batts are not considered an equal.
    1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
    2. Thickness: 2" thick batts at stud cavities (unless noted different on drawings), 3" thick elsewhere.

2.03 EXPANDING FOAM INSULATION

A. DuPont Great Stuff Pro or equal one part polyurethane foam sealant. For conditions where foam will be exposed inside a building (not covered with gypsum board) use DuPont Great Stuff Fireblock or equal.
    1. Conform to ASTM C557-93, D6464, CA25-4 and is UL Class 1 (Flame Spread of 15, Smoke of 20). ASTM E84, E815 and UL 1715 for Fireblock products.
    2. Application temperature range of 25°F to 120°F.
    3. Paintable, stainable and sandable.
    4. Acoustical Rating: Sound transmission class rating of 69.
    5. Minimum R.Value of 4 per inch.

2.04 VAPOR BARRIERS

A. Walls/Attics: Glass reinforced or laminated polyethylene sheet, minimum perm rating, 0.1 when tested in accordance with ASTM-E96, Procedure A.
    1. Vapor Barrier Tape: Compatible polyethylene self-adhesive tape recommended by vapor barrier manufacturer.
    2. Adhesive: Manufacturers vapor-proofing mastic.

B. Under Floor Slabs: Meet requirements of ASTM E1745 Class A.
    1. Materials: Meets Class A, 15 mil minimum thickness, high density polyethylene constructed of 100% virgin high-grade, polyolefin resins conforming to the following properties.

a.	Water Vapor Permeance	ASTM E 96	0.01 perms (US) per ASTM E 1745 Sec. 7.1
b.	Water Vapor Transmission	ASTM E 96	0.004 perms (g/hr-m2)
c.	Water Vapor Barrier	ASTM E 1745	Exceeds Class A (Plastics)
d.	Tensile Strength	ASTM D 882	60 lbs/in.
e.	Puncture Resistance	ASTM D 1709	2200 grams
f.	Life Expectancy	ASTM E 154	Indefinite
g.	Chemical Resistance	ASTM E 154	Unaffected
h.	Peel Adhesion to Concrete	ASTM D 903	8 lbs/in.

    2. Vapor Barrier Accessories:
        a. Seam tape and vapor proofing mastic conforming to the following properties and as recommended by vapor barrier manufacturer:

1)	Water Vapor Permeance	ASTM E 96	0.03 Perms
2)	Tensile Strength (lbs/in)	ASTM D 1970	MD-20.09/TD-26.42
3)	Peel Adhesion (lbs/in)	ASTM D 3330	5.55
4)	Total Thickness		6 mil

        b. Pipe boots constructed from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.
        c. Mastic to have a water vapor transmission rate per ASTM E 96, 0.3 perms or lower.
        d. Material for conduit/pipe bank and/or small gap sealing (when pipe boots will not work or columns are close to an adjacent wall, etc.): Granular Seaming Bentonite with the following properties:
            1) Moisture: 9%
            2) PH of 6 percent suspension: PH 9.5
            3) Plate Water Absorption: 900 w+%

4) Swell Index (ASTM D 5890): 28 ml
5) Specific Gravity: 2.7
6) Calcium Oxide (Ca0): 0.70%
7) Surface Area (N_2 absorption): 20 m^2/gram
8) Bulk Density (uncompacted): 61 lb/ft^3
9) Bulk Density (compacted): 68 lb/ft^3

e. Termination Bar: TB-100 termination bar with sealant ledge, .100" thick x 1" wide extruded aluminum with ¼" x 3/8" slotted holes at 8" o.c. as manufactured by Tru-Fast Corp (1-800-443-9602) or equal. Fasteners to be stainless steel or galvanized for compatibility with aluminum.

2.05 BUILDING WRAP

A. Tyvek Commercial "D" Wrap by DuPont de Nemours, www.dupont.com or equal.

1. High Performance Spunbonded olefin, non-woven, non-perforated with the following performance characteristics:
   a. Air Penetration: Type 1 when tested in accordance with ASTM E 1677.
   b. Water Vapor Transmission: 30 perms, when tested in accordance with ASTM E96, Method B.
   c. Water Penetration Resistance: 235 cm when tested in accordance with AATCC Test Method 127.
   d. Basis Weight: 2.4 oz/yd^2, when tested in accordance with TAPPI Test Method T-410.
   e. Air Infiltration Resistance: Air infiltration at >750 seconds, when tested in accordance with TAPPI Test Method T-460.
   f. Breaking Strength: 33/41 lbs/in., when tested in accordance with ASTM D 822, Method A.
   g. Tear Resistant (Trapezoid) 6/9 lbs when tested in accordance with ASTM D1117.
   h. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E 84. Flame Spread: 15, Smoke Developed: 25.
   i. UV Exposure: Up to 270 days/9 months without harming performance characteristics.
2. Seam Tape: 3" DuPont™ Tyvek® Tape.
3. Fasteners with Self-Gasketing high density polyethylene cap washers.
4. Composite, strip or fluid applied flashing and primer as recommended by manufacturer.
5. Sealants and/or closed cell polyurethane foam insulation as recommended by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation/products.
B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 INSTALLATION-GENERAL

A. Install in accordance with manufacturer's instructions.
B. Install without gaps or voids. Do not compress insulation.
C. Fit insulation tight to exterior side of mechanical and electrical services within plane of insulation.
D. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
E. Ensure overall installation presents flush, level surface.

3.03 BOARD INSTALLATION OVER ROOF DECKS

A. Refer to roofing specifications for installation.

3.04 BATT INSTALLATION

A. Refer to metal or wood stud specification for installation.
B. Install insulation and vapor barrier if spray foam insulation is not being used for vapor barrier in accordance with manufacturer's instructions.
C. Install in exterior cavity spaces without gaps or voids. Do not compress insulation.
D. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
E. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

3.05 PROTECTION

A. Cover top and edges of unfinished wall panel work to protect it from weather and to prevent accumulation of water in cores of panels.

B. If panels become wet inadvertently, allow wet panels to completely dry prior to application of subsequent coverings.

C. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 07 21 00

SECTION 07 31 13
ASPHALT SHINGLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Asphalt shingle roofing.
B. Flexible sheet membranes for eave protection, underlayment, and valley protection.
C. Metal flashing.
D. Nailable roof insulation installed over a base layer of roof insulation to create a vapor barrier.
E. Snow retention system.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data indicating material characteristics, performance criteria, limitations.
C. Samples: Submit two samples of each shingle color indicating color range and finish texture/pattern ; for color selection.
D. Warranty Documentation: Submit a sample warranty.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. Extra Shingles: 100 sq ft (9.29 sq m) of each type and color.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials with labels intact in manufacturer's unopened packaging until ready for installation.
B. Store materials under dry and waterproof cover, well ventilated, and elevated above grade on a flat surface.
C. Protect materials from harmful environmental elements, construction dust, direct sunlight, and other potentially detrimental conditions.
D. When storing roofing materials on roofing system ensure that no damage occurs to supporting members and other materials.

1.04 FIELD CONDITIONS

A. Do not install shingles, eave protection membrane, underlayment or when surface, ambient air, wind chill or temperatures are below 45 degrees F (7 degrees C).

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Provide 10 year manufacturer's warranty for coverage against black streaks caused by algae.
C. Provide 15-year manufacturer's warranty for wind damage.
D. Manufacturer’s 50 year warranty on manufacturing defects: 100% Coverage for materials and labor for first 20 years and prorated thereafter.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Asphalt Shingles:
    1. GAF; Timberline UHD Shingles: www.gaf.com.
    2. Owens Corning Corp; Duration Storm: www.owenscorning.com.

2.02 ASPHALT SHINGLES

A. Asphalt Shingles: Asphalt-coated glass felt, mineral granule surfaced, complying with ASTM D3462/D3462M.
    1. GAF; Timberline Ultra HD Shingles with StainGuard Plus: www.gaf.com.
    2. Owens Corning Corp; Duration Storm: www.owenscorning.com
        a. Fire Resistance: Class A, complying with ASTM E108.
        b. Wind Resistance: Class A, when tested in accordance with ASTM D3161/D3161M.
        c. Fire or Wind Resistance Criteria: Provide UL (DIR) listed and labeled products.
        d. Warranted Wind Speed: Not greater than 60 mph (97 km/h).
        e. Algae resistant.

f. Self-sealing type.
g. Style: Square.
h. Color: As selected by Architect.
i. Ridge Cap Shingle: Manufacturer's standard to match shingles and maintain warranty.

2.03 SHEET MATERIALS

A. Eave and Valley Protection Membrane:
1. Eave and Valley Protection Membrane: Self-adhering polymer-modified asphalt sheet complying with ASTM D1970/D1970M; 40 mil (1 mm) total thickness; with strippable treated release paper and polyethylene sheet top surface.

B. Underlayment: #30, Asphalt-saturated organic roofing felt, unperforated, complying with ASTM D226/D226M.

C. Flexible Flashing: Self-adhering polymer-modified asphalt sheet complying with ASTM D1970/D1970M; 40 mil (1 mm) total thickness; with strippable treated release paper and polyethylene sheet top surface.

2.04 ACCESSORIES

A. Roofing Nails: Standard round wire shingle type, galvanized steel, stainless steel, aluminum roofing nails, or copper roofing nails, minimum 3/8-inch (9.5 mm) head diameter, 12-gauge, 0.109-inch (2.77 mm) nail shank diameter, 1-1/2 inches (38 mm) long and complying with ASTM F1667/F1667M.

B. Asphalt Roof Cement: ASTM D4586/D4586M, asbestos-free.

C. Lap Cement: Fibrated cutback asphalt type, recommended for use in application of underlayment, free of toxic solvents.

D. Plastic Ridge Vents: Extruded plastic with vent openings that do not permit direct water or weather entry; flanged to receive shingles.

E. Plumbing vent flashing: Oatey Galvanized All-Flash or equal.

F. Roof and Nailable roof insulation: Refer to Section 07 21 00 Insulation for products to be used.

G. Snow Retention System: Aluminum, 6061-T6, Heavy Duty 2 Round Bar Snow Bracket, rails, couplers, end collars and caps, ice flags.
1. Ace Clamp: A2 Snow Retention System; www.aceclamp.com.
2. Equivalent products by other manufacturers are acceptable.

2.05 METAL FLASHINGS

A. Steel Sheet Metal: Prefinished and galvanized steel sheet, 26 gauge, 0.0179 inch (0.45 mm) minimum thickness, G90/Z275 hot-dipped galvanized.

B. Metal Drip Edge: Brake-formed sheet metal with at least a 2-inch roof deck flange and a 1-1/2-inch fascia flange with a 3/8-inch drip at lower edge. Furnish the following material in lengths of 8 or 10 feet.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions prior to starting this work.

B. Verify that roof deck is of sufficient thickness to accept fasteners.

C. Verify that roof penetrations and plumbing stacks are in place and flashed to deck surface.

D. Verify roof openings are correctly framed.

E. Verify deck surfaces are dry, free of ridges, warps, or voids.

3.02 INSULATION

A. Install base roof insulation in a minimum thickness of 1 inch (25.4 mm) with nailable roof insulation installed over, with staggered joints to create a vapor barrier.

3.03 PREPARATION

A. Seal roof deck joints wider than 1/16 inch (1.5 mm) as recommended by shingle manufacturer.

B. At areas where eave and valley protection membrane is to be adhered to substrate, fill knot holes and surface cracks with latex filler.

C. Broom clean deck surfaces before installing underlayment or eave protection.

D. Install eave edge flashings tight with fascia boards, weather lap joints 2 inches (50 mm) and seal with plastic cement, and secure flange with nails.

3.04 INSTALLATION

A. Eave and Valley Protection Membrane:
   1. Install eave protection membrane from eave edge to minimum 48 inches (1,220 mm) up-slope beyond interior face of exterior wall.
   2. Install valley protection up valley, roll centered on valley.

B. Underlayment:
   1. Roof Slopes Up to 4:12: Install a layer of eave protection membrane on entire roof.
   2. Roof Slopes Greater Than 4:12: Install underlayment perpendicular to slope of roof, with ends and edges weather lapped minimum 4 inches (100 mm); stagger end laps of each consecutive layer, nail in place, and weather lap minimum 4 inches (100 mm) over eave protection.
   3. Weather lap and seal watertight with plastic cement any items projecting through or mounted on roof.

C. Metal Flashing:
   1. Install flashings in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
   2. Weather lap joints minimum 2 inches (50 mm) and seal weather tight with plastic cement.
   3. Secure in place with nails at 16" inches (406.4 mm) on center, and conceal fastenings.
   4. Items Projecting Through or Mounted on Roofing: Flash and seal weather tight with plastic cement.

D. Shingles:
   1. Install shingles in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
      a. Fasten individual shingles using two nails per shingle, or as required by manufacturer and local building code, whichever is greater.
      b. Fasten strip shingles using four nails per strip, or as required by manufacturer and local building code, whichever is greater.
   2. Place shingles in straight coursing pattern with 5-inch (125 mm) weather exposure to produce double thickness over full roof area, and provide double course of shingles at eaves.
   3. Project first course of shingles 3/4 inch (19 mm) beyond fascia boards.
   4. Extend shingles 1/2 inch (13 mm) beyond face of gable edge fascia boards.
   5. Complete installation to provide weathertight service.

3.05 INSTALLATION - VALLEY PROTECTION

A. Install closed cut valley protection in accordance with NRCA Recommendations.

3.06 PROTECTION

A. Notify the General Contractor and Construction Manager that traffic over finished roof surface is not permitted.

B. Touch-up, repair, or replace damaged asphalt shingles or accessories before Date of Substantial Completion.

END OF SECTION 07 31 13

SECTION 07 46 46
FIBER-CEMENT SIDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fiber-cement siding including all trim, fascia, moulding and accessories.
B. Fiber-cement panel system including all trim, fascia, moulding and accessories.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Submit manufacturer's data sheets on each product to be used.
C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and methods of anchorage.
D. Warranty: Submit sample warranty for the specified duration.

1.03 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Sustainable Waste Management and Disposal for packaging waste requirements.
B. Deliver and store materials in manufacturer's unopened packaging, with labels intact, until ready for installation.
C. Store products under waterproof cover and elevated above grade, on a flat surface.

1.04 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Product warranty: Limited, non-prorated product warranty.
   1. Duration: 15 years.
C. Finish warranty: Limited product warranty against peeling, cracking and chipping.
   1. Duration: 15 years.

PART 2 PRODUCTS

2.01 FIBER-CEMENT SIDING

A. Panels: Vertically oriented panels made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186, Type A, Grade II; with machined edges, for nail attachment.
   1. Texture: Smooth.
   2. Length (Height): 96 inches (2400 mm), nominal.
   3. Width: 48 inches (1220 mm).
   4. Thickness: 5/16 inch (8 mm), nominal.
   5. Finish: Factory applied primer.
   6. Field Painted. Color to be selected by Architect from manufacturer's full range of standard colors.
   7. Products:
      a. James Hardie Building Products, Inc; Hardie Reveal Panel: www.jameshardie.com.
      b. Equivalent products by other manufacturers are acceptable.

2.02 ACCESSORIES

A. Furring Strips, Metal: Galvanized metal channels.
B. Fasteners
   1. Wood Framing Fasteners:
      a. Corrosion resistant ring shank nails. Shank, length and head size as recommended by siding manufacturer.
      b. Wood Framing into WSP: Head corrosion resistant ribbed wafer head screws, size as recommended by siding manufacturer.
   2. Metal Framing:
      a. Head self-drilling, corrosion resistant S-12 ribbed buglehead screws, size as recommended by siding manufacturer.
      b. Metal Framing: ET&F Pin or equivalent pneumatic fastener, size as recommended by siding manufacturer.

C. Trim: Same material and texture as siding.
D. Sealant: Elastomeric, polyurethane or silyl-terminated polyether/polyurethane, and capable of being painted.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrate, clean and repair as required to eliminate conditions that would be detrimental to proper installation.
B. Verify that weather barrier has been installed over substrate completely and correctly.
C. Do not begin until unacceptable conditions have been corrected.
D. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Protect surrounding areas and adjacent surfaces during execution of this work.
B. Install Sheet Metal Flashing:
    1. Above door and window trim and casings.
    2. Above horizontal trim in field of siding.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations.
    1. Read warranty and comply with terms necessary to maintain warranty coverage.
    2. Use trim details as indicated on drawings.
    3. Touch up field cut edges before installing.
    4. Pre-drill nail holes if necessary to prevent breakage.
B. Allow space for thermal movement between both ends of siding panels that butt against trim; seal joint between panel and trim with specified sealant.
C. Joints in Vertical Siding: Install Z-flashing in horizontal joints between successive courses of vertical siding.
D. Do not install siding less than 6 inches (152 mm) from ground surface, or closer than 1 inch (25.4 mm) to roofs, patios, porches, and other surfaces where water may collect.
E. After installation, seal joints except lap joints of lap siding; seal around penetrations, and paint exposed cut edges.

3.04 PROTECTION

A. Protect installed products until Date of Substantial Completion.
B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 07 46 46

SECTION 07 53 00
EPDM MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. EPDM fully adhered roofing system.
B. Patching of existing EPDM fully adhered roofing system.
C. Re-roof projects:
    1. Removal of existing coping, wood curbing as shown on drawings, cants, built-up roofing system and insulation down to existing deck.
    2. Raising of mechanical equipment and curbs. Adjusting heights of roof drains, if required. Extension of plumbing vents through roof, if required. Removal and re-hook of mechanical equipment as necessary.
    3. Clean-up and re-sodding of any damaged lawns.
D. Insulation, flat tapered
E. Thermal barrier.
F. Cover boards.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meeting: Convene a pre-installation meeting one week before starting work of this section; require attendance by all affected installers; review preparation and installation procedures and coordination and scheduling necessary for related work.
    1. Attendance is mandatory for roofing contractor, roofing foreman, roofing manufacturer's representative, Architect's representative, Owner's representative, sheet metal subcontractor, carpentry subcontractor and anyone else responsible for items penetrating or in contact with the roof.
    2. Agenda:
        a. Review in detail Architect's specifications, roof plans and all roof flashing details and sheathing materials for the back side of the parapet.
        b. If a manufacturer's specification is used, review and resolve all deviations or differences from Architect's specifications.
        c. If Factory Mutual or Underwriters Laboratories requirements are part of specification, review and understand these requirements, and resolve all conflicts between the FM or UL specifications and Architect's/manufacturer's specifications.
        d. Review roof plans; for slope, deck type, drainage, membrane attachment, expansion joints flashing and details. Resolve all conflicts between what is considered good roofing practice and specifications.
        e. Review proposed roofing system and recommended work practices for its installation.
        f. Study all plans to determine whether different roof areas have different requirements.
        g. Designate which areas on site will be available for use as storage and working areas.
        h. Review procedure to be followed to provide proper protection of roof system during and after construction of roof.
        i. On occupied structures, review means and methods to be utilized to maintain structure weather tight during reroofing.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Shop Drawings:
    1. Document the following information on plans through coordination with other trades and field verification:
    2. Camber of roof structure.
    3. Roof structure slope and elevations of deck.
    4. Location of roof and overflow drains.
    5. Elevations of overflow scuppers relative to roof deck.
    6. Indicate potential drainage problem areas due to insulation layout, camber, slope of deck and roof/overflow drain locations.

7. On existing roofs, verify roof deck elevations by coring existing roofing system.
8. Plans indicating roof size, location and type of penetrations, roof insulation make-up and layout indicating slopes and crickets and coordination/field verification information.
9. Base flashings and membrane terminations.
10. Penetration details.
11. If deviations or modifications to indicated details are necessary or desired, clearly indicate for architects review.
12. If there are no items submitted, it will be assumed that all the details on the drawings are acceptable for the warranty and to install the roofing. RFI's will be rejected once construction starts.

C. Samples: If insulation manufacturer is different than roofing manufacturer, submit sample insulation together with manufacturer's written acceptance.
D. Submit test documentation (UL 1256 or NFPA 276) if the thermal barrier is proposed to be deleted. Note there is no test for acoustical decks, so a thermal barrier will be required for those applications.
E. Manufacturer's approval of the installing contractor.
F. Warranty: Submit manufacturer's sample warranty.

1.04 QUALITY ASSURANCE

A. Installer: Currently approved, in writing, by manufacturer of system prior to awarding of roofing contract.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact.
B. Store materials in weather protected environment, clear of ground and moisture.
C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.
D. Protect foam insulation from direct exposure to sunlight.

1.06 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather.
B. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
D. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Provide a No Dollar Limit Warranty (NDL), from manufacturer; warranty to run from date of substantial completion.
C. Duration: 30 year
D. For patching of existing warrantied roof, maintain existing warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. System by Johns Manville, www.jm.com is specified.
B. Equivalent systems by the following manufacturers are acceptable:
1. Carlisle Roofing Systems, Inc: www.carlisle-syntec.com.
2. Elevate: www.holcimelevate.com.
3. GenFlex: www.genflex.com.
4. Versico Roofing Systems: www.versico.com.

C. Other companies who manufacture their own membranes may submit for prior approval.

2.02 ROOFING SYSTEM - FULLY ADHERED

A. # SE9A Single Ply, Fully Adhered, 90 mil EPDM membrane, non-reinforced, with Factory-Installed Tape (FIT) sidelaps.
B. Insulation:
1. Provide insulation as specified in Section 07 21 00 Insulation.

2.03 ASSOCIATED MATERIALS

A. Seaming Materials: As recommended by membrane manufacturer.
B. Membrane Fasteners: As recommended by and approved by membrane manufacturer.
C. Vapor Retarders: Use one of the following, depending on the roof deck substrate:
   1. Base roof insulation installed in two layers (with a perm per layer less than or equal to 1.0), joints staggered.
   2. 6 mil virgin polyethylene with manufacturer's seam tape.
   3. Self adhering, tri-laminate woven polyethylene, non slip, UV protected top surface:
      a. JM Vapor Barrier SA; www.jm.com.
D. Flexible Flashing Material: Same material as membrane.

2.04 THERMAL BARRIER

A. Thermal Barrier: Gypsum type as recommended by roofing manufacturer.
B. Note: Thermal barrier may be omitted if UL 1256 or NFPA 276 assembly test reports indicate such (refer to IBC 2603.4.1.5), with exception to all acoustical decks, as no test reports exist allowing deletion of the thermal barrier.

2.05 COVER BOARDS

A. Cover Boards: Glass-mat faced gypsum panels complying with ASTM C1177/C1177M.
   1. Thickness: 1/4 inch (6.4 mm), fire-resistant.
   2. Products:
      a. Georgia-Pacific; DensDeck Prime with EONIC Technology: www.densdeck.com.
      b. USG Corporation; Securock Ultralight Glass-Mat Roof Board: www.usg.com.

2.06 ACCESSORIES

A. Roofing Expansion Joint Flashing: Sheet butyl.
B. Roofing expansion joint insulation: Exterior Batt Insulation as specified in Section 07 21 00, Insulation.
C. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.
D. Insulation Fasteners: Appropriate for purpose intended.
   1. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.
E. Membrane Adhesive: As recommended by membrane manufacturer.
F. Thinners and Cleaners: As recommended by adhesive manufacturer, compatible with membrane.
G. Roofing Nails: Galvanized, hot-dipped type, size and configuration as required to suit application.
H. Strip Reglet Devices: Galvanized steel, maximum possible lengths per location, with attachment flanges.
I. Flexible Flashings/Underlayment under metal: Grace Ice and Water Shield; www.gcpat.com or equal.
   1. 40 mil rubberized asphalt adhesive backed by high density cross laminated polyethylene.
   2. Tensile Strength: 250 psi per ASTM D412 (Die C Modified).
   3. Elongation: 250% per ASTM D412 (Die C Modified).
J. Sealants: As recommended by membrane manufacturer.
K. Walkway Pads:
   1. Size: 30" x 30" x 3/8" thick

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.
B. Verify deck is supported and secure.
C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
D. Verify deck surfaces are dry and free of snow or ice.
E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and are in place.

3.02 DEBRIS REMOVAL

A. Prior to commencing work, provide and locate where directed, a dumpster or dump truck adjacent to building.
B. Construct an enclosed chute from roof for removal of debris from roof area.
C. Have waste removed from premises and legally disposed of.

3.03 PREPARATION - WOOD DECK

A. Verify flatness and tightness of joints in wood decking; fill knot holes with latex filler.
B. Confirm dry deck by moisture meter with 12 percent moisture maximum.

3.04 PREPARATION - METAL DECK

A. Install thermal barrier deck sheathing on metal deck.
    1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.
    2. Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface.
B. Mechanically fasten thermal barrier-sheathing to roof deck, in accordance with Factory Mutual recommendations and roofing manufacturer's instructions.
    1. Over entire roof area, fasten sheathing using six fasteners with washers per sheathing board.

3.05 INSTALLATION - VAPOR RETARDER AND INSULATION, UNDER MEMBRANE

A. 6 mil virgin polyethylene:
    1. Lap joints minimum of 6" inches and seal all seams with seam tape.
B. Self-adhering Vapor Retarder:
    1. Install per manufacturer's instructions.
C. Extend vapor retarder under cant strips and blocking.
D. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.
E. Attachment of Insulation:
    1. Mechanically fasten first layer of insulation to deck in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.
    2. Embed second layer of insulation into full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.
F. Attachment of Insulation:
    1. Embed layer of insulation in full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.
G. Cover Boards: Mechanically fasten or adhere cover boards in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.
H. Lay and adhere subsequent layers of insulation with joints staggered minimum 6 inches (152 mm) from joints of preceding layer.
I. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
J. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
K. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
L. At roof drains, use factory-tapered boards to slope down to roof drains over a distance as detailed on the drawings.
M. Do not apply more insulation than can be covered with membrane in same day.

3.06 INSTALLATION - MEMBRANE

A. Install elastomeric membrane roofing system in accordance with manufacturer's recommendations and NRCA (WM) applicable requirements.
B. At gravel stops, extend membrane under gravel stop and to the outside face of the wall.
C. Around roof penetrations, seal flanges and flashings with flexible flashing.
D. Install roofing expansion joints where indicated. Make joints watertight.
E. Coordinate installation of roof drains and sumps and related flashings.

3.07 FIELD QUALITY CONTROL

A. Provide free access to construction operations at project site and cooperate with appointed firm.

B. Special Inspection

1. Special Inspection shall be performed by qualified parties as specified herein, and in accordance with the provisions of Section 01 4533.
2. The Owner will provide the following tests and inspections:
    a. Periodic Inspections of Continuous Air Barrier installation verification.
    b. Verify air barrier is installed per manufacturers recommendations.
    c. Periodic field inspection of the continuous air barrier materials and assemblies shall be conducted during construction while the continuous air barrier is still accessible for inspection and repair to verify and document compliance, as it applies, with the requirements of:
        1) ASTM E2178, ASTM E2357, ASTM E1677, ASTM E1680, ASTM E283
3. Provide a written report(s) documenting the continuous air barrier inspection per specification section 01 45 16.

C. Contractor to correct any deficiencies noted in Special Inspection reports.

3.08 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Remove bituminous markings from finished surfaces.

C. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.

D. Repair or replace defaced or damaged finishes caused by work of this section.

E. Restore damaged lawns by filling in ruts with black dirt and re-sodding.

3.09 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 07 53 00

SECTION 07 61 00
SHEET METAL ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sheet metal standing seam roofing, associated flashings, and underlayment.
B. Counterflashings.
C. Snow retention system.
D. Sealants for joints within sheet metal fabrications.
E. Nailable roof insulation installed over a base layer of roof insulation to create a vapor barrier.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meeting: Convene one week before installation of wood blocking or sheathing on back side of parapet.
   1. Agenda:
      a. Review in detail Architect's specifications, roof plans and all roof and flashing details.
      b. If a manufacturer's specification is used, review and resolve all deviations or differences from Architect's specifications.
      c. Review roof plans; for slope, deck type, drainage, underlayment, insulation expansion joints flashing and details. Resolve all conflicts between what is considered good roofing practice and specifications.
      d. Review proposed roofing system and recommended work practices for its installation.
      e. Study all plans to determine whether different roof areas have different requirements.
      f. Review procedure to be followed to provide proper protection of roof system during and after construction of roof.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on metal types/profiles/ spacing of standing seams, finishes.
C. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
D. Samples: Submit 2 samples in size illustrating metal finish color.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA (ASMM) requirements and standard details, except as otherwise noted.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
B. Prevent contact with materials that could cause discoloration or staining.

1.06 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Furnish manufacturer’s standard 20-year warranty stating architectural fluorocarbon finish.
C. Duration: 30 year

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sheet Metal Roofing Manufacturers:
   1. Products by Elevate: www.holcimelevate.com.com are specified.
   2. Equivalent products by other manufacturers with matching colors are acceptable.

2.02 SHEET MATERIALS

A. Galvanized Steel Sheet: ASTM A653/A653M, with G90/Z275 zinc coating; 22 gauge (0.0299 inch) (0.76 mm) minimum base metal thickness.
B. Pre-Finished Galvanized Steel Sheet: ASTM A653/A653M, with G90/Z275 zinc coating; 22 gauge, 0.0299 inch (0.76 mm) minimum base metal thickness, shop pre-coated with PVDF (polyvinylidene fluoride) coating.

C. Roof and Nailable Roof Insulation: Refer to Section 07 21 00 Insulation, for products to be used.
D. Thermal Barrier: Gypsum type as recommended by roofing manufacturer.
   1. Note: Thermal barrier may be omitted if UL 1256 or NFPA 276 assembly test reports indicate such (refer to IBC 2603.4.1.5), with exception to all acoustical decks, as no test reports exist allowing deletion of the thermal barrier.
E. Vapor Retarders: Use one of the following, depending on the roof deck substrate:
   1. Base and nailable roof insulation installed in two layers (with a perm per layer less than or equal to 1.0), joints staggered.
   2. 6 mil virgin polyethylene with manufacturer's seam tape.
   3. Self adhering, tri-laminate woven polyethylene, non slip, UV protected top surface:
      a. JM Vapor Barrier SA; www.jm.com.

2.03 STANDING SEAM SYSTEMS

A. System: UC-14, factory formed panels with concealed clips and snap together continuous interlocking seams.
   1. Seam height: 1 3/4"
   2. Seam spacing: 9 3/4' to 17 3/4" (depending on manufacturer)
B. Provide manufacturer’s standard accessories and other items essential to completeness of roof installation including anchor clips, trim, ridge and hip caps, closures, flashings and fascia.

2.04 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Fabricate starter strips, interlockable with sheet.
C. Form pieces in longest practical lengths.
D. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
E. Form material with standing seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
F. Fabricate corners from single piece with minimum 18-inch (457 mm) long legs; seam for rigidity, seal with sealant.
G. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.
H. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel; return and brake edges.

2.05 FINISHES

A. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
B. Color: As selected by Architect from manufacturer's standard colors.
C. Primer Coat: On coated sheets, finish concealed side of sheet with primer compatible with finish system as recommended by finish system manufacturer.

2.06 ACCESSORIES

A. Fasteners: Galvanized steel or stainless steel.
B. Flexible Flashings/Underlayment: GCP Applied Systems: www.gcpat.com “ Grace Ice and Water Shield” or equal. Install under all sheet metal and metal roofing.
   1. 40 mil rubberized asphalt adhesive backed by high density cross laminated polyethylene.
   2. Tensile Strength: 250 psi per ASTM D412 (Die C Modified).
   3. Elongation: 250% per ASTM D412 (Die C Modified).
C. Slip Sheet: Rosin sized building paper.
D. Primer: Zinc molybdate type.
E. Protective Backing Paint: Zinc molybdate alkyd.
F. Concealed Sealants: Non-curing butyl sealant.
G. Exposed Sealants: ASTM C920 elastomeric sealant, with minimum movement capability as recommended by manufacturer for sealed substrates; color to match adjacent material.
H. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

I. Snow Retention System: Standing seam rib mounted (non-penetrating) “ColorGard” by S5! Rail system as manufactured by Metal Roof Innovations; Colorado Springs, Colorado; www.s-5.com or equal.
   1. System to be manufactured of aluminum or stainless steel.
   2. Provide all necessary hardware, clamps, end caps and snow clips at each standing seam panel.
   3. Kynar color to match roofing panels.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect roof deck to verify deck is clean and smooth, free of depressions, waves, or projections, properly sloped to drains.
B. Verify deck is dry and free of snow or ice. Verify joints in wood deck are solidly supported and fastened.
C. Verify correct placement of wood nailers and insulation positioning between nailers.
D. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, reglets are in place, and nailing strips located.
E. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 INSULATION

A. Install base roof insulation in a minimum thickness of 1 inch (25.4 mm) with nailable roof insulation installed over, with staggered joints to create a vapor barrier.

3.03 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.
B. Back paint concealed metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.4 mm).

3.04 INSTALLATION

A. Roofing:
   1. Apply underlayment over entire roof area, as follows:
   2. Apply slip sheet in one layer, laid loose.
   3. Cleat and seam sheet metal roofing joints.
   4. Use butyl tape to seal concealed joints between metal roofing surfaces.

3.05 INSTALLATION - ROOFING

A. Apply underlayment over entire roof area.
B. Apply slip sheet in one layer, laid loose.
C. Cleat and seam all joints.
D. Use roof cement for joints between metal and bitumen for joints between metal and felts.
E. Provide formed metal pans for protrusions through roof; fill pans watertight with roof cement.
F. Install snow retention system per manufacturers recommended instructions.

3.06 INSTALLATION - STANDING SEAM ROOFING

A. Comply with SMACNA (ASMM) details.
B. Lay sheets with long dimension perpendicular to eaves. Apply pans beginning at eaves.
C. Lock cleats into seams and flatten.
D. Stagger transverse joints of roofing sheets.
E. At eaves and gable ends, terminate roofing by hooking over edge strip.
F. Seam panels per manufacturer's instructions.
G. Terminate standing seams at ridge and hips by turning down with tapered fold.
H. Form valleys of sheets not exceeding 10 feet (3 m) in length, and lap joints 6 inches (152 mm) in direction of drainage.
I. Extend valley sheet minimum 6 inches (152 mm) under roofing sheets.
J. At valley, double fold valley and roofing sheets and secure with cleats spaced 18 inches (457 mm) on center.
K. Install Snow Retention System per manufacturer's instructions.

3.07 INSTALLATION - FLASHINGS

A. Insert flashings into reglets to form tight fit.
   1. Seal flashings into reglets with sealant.
B. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
C. Cleat and seam each joint.
D. Apply roof cement compound between metal flashings and felt flashings.
E. Fit flashings tight in place, and make corners square, surfaces true and straight in planes, and lines accurate to profiles.

3.08 FIELD QUALITY CONTROL

A. Provide free access to construction operations at project site and cooperate with appointed firm.
B. Special Inspection
   1. Special Inspection shall be performed by qualified parties as specified herein, and in accordance with the provisions of Section 01 4533.
   2. The Owner will provide the following tests and inspections:
      a. Periodic Inspections of Continuous Air Barrier installation verification.
      b. Verify air barrier is installed per manufacturers recommendations.
      c. Periodic field inspection of the continuous air barrier materials and assemblies shall be conducted during construction while the continuous air barrier is still accessible for inspection and repair to verify and document compliance, as it applies, with the requirements of:
         1) ASTM E2178, ASTM E2357, ASTM E1677, ASTM E1680, ASTM E283
   3. Provide a written report(s) documenting the continuous air barrier inspection per specification section 01 45 16.
C. Contractor to correct any deficiencies noted in Special Inspection reports.

3.09 PROTECTION

A. Do not permit traffic over unprotected roof surface.

END OF SECTION 07 61 00

SECTION 07 62 00
SHEET METAL COPING AND FLASHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sheet metal coping (pre-fabricated coping or ANSI-SPRI ES-1 approved contractor fabricated coping) , flashing and counterflashing as shown on drawings.
B. Sheet metal gutters and downspouts.
C. Sheet metal scuppers and downspouts.
D. Flexible flashing/underlayment under all metal.
E. Sheet metal vented soffit systems.
F. Sealants for joints within sheet metal fabrications.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details. Indicate locations of pre-finished metal (if there is only one color for the entire project, this item is not required).
    1. If there are no items submitted, it will be assumed that all the details on the drawings are acceptable for all conditions on site to install a leak free system. RFI's will be rejected once construction starts.
C. Samples: Submit 2 samples in size illustrating metal finish color.
D. For Contractor fabricated ANSI/SPRI ES-1 coping and /or fascia submit documentation that contractor has a NRCA authorized fabricator agreement for NRCA's UL Certification for ANSI/SPRI ES-1.

1.03 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sheet Metal Flashing and Trim:
    1. Products by Elevate: www.holcimelevate.com are specified.
    2. Equivalent products by other manufacturers with matching colors are acceptable.

2.02 SHEET MATERIALS

A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 22 gauge, 1/32 inch (0.7 mm) thick base metal.
B. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch (0.61 mm) thick base metal, shop pre-coated with PVDF coating.
C. Aluminum: ASTM B209 (ASTM B209M); 20 gauge, 0.032 inch (0.81 mm) thick; anodized finish of color as selected.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Form pieces in longest possible lengths.
C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
E. Fabricate corners from one piece with minimum 18-inch (450 mm) long legs; seam for rigidity, seal with sealant.
F. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel. Return and brake edges.

2.04 ANSI/SPRI ES-1 FABRICATION

A. Pre-fabricated Copings:
   1. If contractor can demonstrate that fabricated copings/fascias meet the requirements of ANSI/SPRI ES-1, pre-fabricated copings are not required]
   2. Coping: Firestone Building Products – UNA-Edge Coping System. Other manufacturers meeting specified requirements are acceptable, subject to approval of color and warranty.
   3. Meet ANSI / SPRI ES-1 wind design standards for conformance to requirements of International Building Code. Note: For Contractor fabricated coping, provide documentation that contractor has a NRCA authorized fabricator agreement for NRCA's UL Certification for ANSI/SPRI ES-1.
   4. Materials
   5. Coping cover shall be 24 gauge galvanized with Kynar 500 finish.
   6. Accessories to include stainless steel anchor chips, concealed splice plates, coping cleats, and corrosion resistant fasteners / neoprene washers. Factory fabricated corners, end caps, frees, scuppers and sups with "quick lock" or welded seams.
   7. Provide factory fabricated special sizes, shapes, as required / detailed.

B. Pre-Fabricated Fascia:
   1. If contractor can demonstrate that fabricated openings/fascias meet the requirements of ANSI/SPRI ES-1, pre-fabricated copings are not required.
   2. Fascia: Firestone Building Products: UNA-Edge gravel stop system. Other manufacturers meeting specified requirements are acceptable, subject to approval of color and warranty.
      a. Meet ANSI/SPRI ES-1 wind design standards for conformance to requirements of International Building Code. Note: For Contractor fabricated coping, provide documentation that contractor has a NRCA authorized fabricator agreement for NRCA's UL Certification for ANSI/SPRI ES-1.
      b. Fascia cover shall be 24 gauge galvanized with Kynar 500 finish.
      c. Accessories to include extruded aluminum anchor bar, anchor bar splice plates, closed cell compression gaskets, and corrosion resistant fasteners.
      d. Sizes as detailed.

2.05 GUTTER AND DOWNSPOUT FABRICATION

A. Gutters: SMACNA (ASMM) Rectangular profile.
B. Downspouts: Rectangular profile.
C. Gutters and Downspouts: Size indicated.
D. Accessories: Profiled to suit gutters and downspouts.
   1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
E. Seal metal joints.

2.06 SCUPPER AND DOWNSPOUT FABRICATION

A. Fabricate scuppers and/or overflow scuppers as detailed.
B. Downspouts: 3 sided rectangular profile, size indicated.
C. Accessories: Profiled to suit downspouts.
   1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.

2.07 SOFFIT PANELS

A. Vented Soffit Panels: Elevate Una-Clad UC-500.
   1. 22 gauge, Kynar coated galvanized steel.
   2. Depth: 1 inch (25.4 mm).
   3. Width:
      a. 12 inch (304.8 mm).

2.08 ACCESSORIES

A. Fasteners: Galvanized steel, with soft neoprene washers.
B. Flexible Flashings/Underlayment under metal: Grace Ice and Water Shield; www.gcpat.com or equal.
   1. 40 mil rubberized asphalt adhesive backed by high density cross laminated polyethylene.
   2. Tensile Strength: 250 psi per ASTM D412 (Die C Modified).
   3. Elongation: 250% per ASTM D412 (Die C Modified).

C. Primer Type: Zinc chromate.
D. Protective Backing Paint: Zinc molybdate alkyd.
E. Concealed Sealants: Non-curing butyl sealant.
F. Exposed Sealants: ASTM C920; elastomeric silicone polymer sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
G. Plastic Cement: ASTM D4586/D4586M, Type I.
H. Solder: ASTM B32; Sn50 (50/50) type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.
B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.38 mm).

3.03 INSTALLATION

A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
B. Apply plastic cement compound between metal flashings and felt flashings.
C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
D. Secure gutters and downspouts in place with concealed fasteners.
E. Slope gutters 1/4 inch per 10 feet (2.1 mm per m), minimum.

END OF SECTION 07 62 00

SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.
   1. Two hour and less.
B. Acoustic and Smoke Spray is specified in Section 07 21 00 Insulation and installed by Sections 04 20 00 Non-bearing Unit Masonry and 09 21 16 Gypsum Wallboard Assemblies.
C. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.
D. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
E. Openings between structurally separate sections of wall or floors.
F. Gaps between the top of walls and ceilings or roof assemblies.
G. Openings and penetrations in fire-rated partitions or walls containing fire doors.
H. Openings around structural members which penetrate floors or walls.
I. Labeling of fire stopped penetrations.
J. Firestopping at rated precast concrete walls.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
C. Sustainable Design Submittal: Submit VOC content documentation for nonpreformed materials.

1.03 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
   1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.

1.04 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Firestopping Manufacturers:
   1. Hilti, Inc: www.us.hilti.com.
   2. HoldRite, a Brand of Reliance Worldwide Corporation: www.holdrite.com.
   3. Specified Technologies Inc: www.stifirestop.com.
   4. Other manufacturers with similar products are acceptable.

2.02 MATERIALS

A. Firestopping Materials: Any materials meeting requirements.
B. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.
C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
D. Fire Ratings: Refer to Code Drawings for required ratings.
E. Identification Labels
   1. Pressure-sensitive, self adhesive, preprinted vinyl labels with the following verbiage:
   2. “Warning: Fireblocking Application – Do Not Disturb. Notify Building Management of Any Damage”

3. Installing Contractor's name, address and phone number.
4. Date of installation.
5. Fireblocking/Stopping product manufacturer's name.

F. Firesafing material: Formaldehyde free semi-rigid mineral wool.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.

B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
1. Movement: Provide systems that have been tested to show movement capability as indicated.

C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
1. Movement: Provide systems that have been tested to show movement capability as indicated.
2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

2.04 FIRESTOPPING FOR (2) TWO HOUR AND LOWER RATED ASSEMBLIES

A. FIRESTOPPING FOR PERIMETER CONTAINMENT
1. Perimeter Joint Systems That Have Not Been Tested For Movement Capabilities (Static-S):
a. 2 Hour Construction: UL System CW-S-0002; Specified Technologies Inc. AS200 Elastomeric Spray.
b. 2 Hour Construction: UL System CW-S-0002; Specified Technologies Inc. Fast Tack Firestop Spray.
c. 2 Hour Construction: UL System CW-S-0003; Specified Technologies Inc. Fast Tack Firestop Spray.
d. 2 Hour Construction: UL System CW-S-0007; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
2. Perimeter Joint Systems That Have Movement Capabilities (Dynamic-D):
a. 2 Hour Construction: UL System CW-D-1004; Specified Technologies Inc. AS200 Elastomeric Spray.
b. 2 Hour Construction: UL System CW-D-1004; Specified Technologies Inc. Fast Tack Firestop Spray.
c. 2 Hour Construction: UL System CW-D-1011; Specified Technologies Inc. Fast Tack Firestop Spray.
d. 2 Hour Construction: UL System CW-D-2042; Specified Technologies Inc. Fast Tack Firestop Spray.

B. FIRESTOPPING FOR FLOOR-TO-FLOOR, FLOOR-TO-WALL, HEAD-OF-WALL, AND WALL-TO-WALL JOINTS

1. Concrete and Concrete Masonry Walls and Floors:
    a. Floor-to-Floor Joints:
        1) 2 Hour Construction: UL System FF-D-1013; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
    b. Head-of-Wall Joints at Concrete/Concrete Masonry Wall to Concrete Over Metal Deck Floor:
        1) 2 Hour Construction: UL System HW-D-0039; Specified Technologies Inc. ES Elastomeric Firestop Sealant.
        2) 2 Hour Construction: UL System HW-D-0181; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
        3) 2 Hour Construction: UL System HW-D-1037; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
    c. Head-of-Wall Joints at Concrete/Concrete Masonry Wall to Concrete Floor:
        1) 2 Hour Construction: UL System HW-D-0268; Hilti CP 606 Flexible Firestop Sealant.
        2) 2 Hour Construction: UL System HW-D-0312; Specified Technologies Inc. SIL Silicone Sealant.
    d. Concrete/Concrete Masonry Wall-to-Wall Joint Systems That Have Movement Capabilities (Dynamic-D):
        1) 2 Hour Construction: UL System WW-D-0017; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
        2) 2 Hour Construction: UL System WW-D-0032; Hilti CP 606 Flexible Firestop Sealant.
2. Gypsum Board Walls:
    a. Wall-to-Wall Joints That Have Not Been Tested For Movement Capabilities (Static-S):
        1) 2 Hour Construction: UL System WW-S-0063; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
    b. Wall-to-Wall Joints That Have Movement Capabilities (Dynamic-D):
        1) 2 Hour Construction: UL System WW-D-0180; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
        2) 2 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.
        3) 1 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.
    c. Head-of-Wall Joints at Underside of Steel Beam and Concrete Over Metal Deck Floor with Sprayed On Fireproofing:
        1) 2 Hour Construction: UL System HW-D-0252; Specified Technologies Inc. AS200 Elastomeric Spray.
        2) 2 Hour Construction: UL System HW-D-0259; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
    d. Head-of-Wall Joints at Underside of Flat Concrete:
        1) 2 Hour Construction: UL System HW-D-0044; Specified Technologies Inc. AS200 Elastomeric Spray.
        2) 2 Hour Construction: UL System HW-D-0079; Specified Technologies Inc. ES Elastomeric Firestop Sealant.
        3) 2 Hour Construction: UL System HW-D-0371; Specified Technologies Inc. SpeedFlex Joint Profile System.
        4) 2 Hour Construction: UL System HW-D-0689; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
        5) 2 Hour Construction: UL System HW-D-0696; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
        6) 2 Hour Construction: UL System HW-D-1068; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
        7) 2 Hour Construction: UL System HW-D-0757; Hilti CFS-TTS Top Track Seal.

8) 1 Hour Construction: UL System HW-D-0079; Specified Technologies Inc. ES Elastomeric Firestop Sealant.
9) 1 Hour Construction: UL System HW-D-0371; Specified Technologies Inc. SpeedFlex Joint Profile System.
10) 1 Hour Construction: UL System HW-D-0689; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
11) 1 Hour Construction: UL System HW-D-0696; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
12) 1 Hour Construction: UL System HW-D-1068; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
13) 1 Hour Construction: UL System HW-D-0757; Hilti CFS-TTS Top Track Seal.

e. Head-of-Wall Joints at Concrete Over Metal Deck:
1) 2 Hour Construction: UL System HW-D-0034; Specified Technologies Inc. ES Elastomeric Firestop Sealant.
2) 2 Hour Construction: UL System HW-D-0043; Specified Technologies Inc. AS200 Elastomeric Spray.
3) 2 Hour Construction: UL System HW-D-0099; Specified Technologies Inc. SpeedFlex Joint Profile System.
4) 2 Hour Construction: UL System HW-D-0363; Specified Technologies Inc. SpeedFlex Joint Profile System.
5) 2 Hour Construction: UL System HW-D-0365; Specified Technologies Inc. SpeedFlex Joint Profile System.
6) 2 Hour Construction: UL System HW-D-0548; Specified Technologies Inc. SpeedFlex Joint Profile System.
7) 2 Hour Construction: UL System HW-D-0749; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
8) 1 Hour Construction: UL System HW-D-0034; Specified Technologies Inc. ES Elastomeric Firestop Sealant.
9) 1 Hour Construction: UL System HW-D-0099; Specified Technologies Inc. SpeedFlex Joint Profile System.
10) 1 Hour Construction: UL System HW-D-0363; Specified Technologies Inc. SpeedFlex Joint Profile System.
11) 1 Hour Construction: UL System HW-D-0365; Specified Technologies Inc. SpeedFlex Joint Profile System.
12) 1 Hour Construction: UL System HW-D-0548; Specified Technologies Inc. SpeedFlex Joint Profile System.
13) 1 Hour Construction: UL System HW-D-0749; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.

f. Head-of-Wall Joints at Concrete Over Metal Deck, Wall Parallel to Ribs:
1) 2 Hour Construction: UL System HW-D-0049; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
2) 2 Hour Construction: UL System HW-D-0184; Hilti CP 606 Flexible Firestop Sealant.
3) 1 Hour Construction: UL System HW-D-0049; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
4) 1 Hour Construction: UL System HW-D-0184; Hilti CP 606 Flexible Firestop Sealant.

g. Head-of-Wall Joints at Concrete Over Metal Deck, Wall Perpendicular to Ribs, Cut to Fit Ribs:
1) 2 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
2) 2 Hour Construction: UL System HW-D-0103; Specified Technologies Inc. ES Elastomeric Firestop Sealant.
3) 1 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.

h. Head-of-Wall Joints at Concrete Over Metal Deck, Wall Perpendicular to Ribs, Not Cut to Fit:
1) 2 Hour Construction: UL System HW-D-0042; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
2) 2 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
3) 1 Hour Construction: UL System HW-D-0042; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
4) 1 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.

C. FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION
1. Blank Openings:
a. In Floors or Walls:
1) 2 Hour Construction: UL System C-AJ-0090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
2) 2 Hour Construction: UL System C-AJ-0015; Specified Technologies Inc. SSM Mortar.
3) 2 Hour Construction: UL System C-AJ-0116; Specified Technologies Inc. Composite Sheet.
4) 2 Hour Construction: UL System C-AJ-0136; Specified Technologies Inc. SSM Mortar.
5) 2 Hour Construction: UL System C-AJ-0171; HoldRite HydroFlame 100 Intumescent Firestop Sealant.
6) 2 Hour Construction: UL System C-AJ-0175; HoldRite HydroFlame 300 SL (Self-Leveling) Silicone Firestop Sealant.
2. Penetrations Through Floors or Walls By:
a. Multiple Penetrations in Large Openings:
1) 2 Hour Construction: UL System C-AJ-2863; HoldRite HydroFlame 100 Intumescent Firestop Sealant.
2) 2 Hour Construction: UL System C-AJ-8143; Hilti FS-ONE MAX Intumescent Firestop Sealant.
3) 2 Hour Construction: UL System C-AJ-8035; Specified Technologies Inc. SSM Mortar.
4) 2 Hour Construction: UL System C-AJ-8055; Specified Technologies Inc. SSP Firestop Putty.
5) 2 Hour Construction: UL System C-AJ-8093; Specified Technologies Inc. SSB Intumescent Firestop Pillows.
6) 2 Hour Construction: UL System C-AJ-8114; Specified Technologies Inc. SSM Mortar.
7) 2 Hour Construction: UL System C-AJ-8115; Specified Technologies Inc. SSM Mortar.
8) 2 Hour Construction: UL System C-AJ-8181; Specified Technologies Inc. Composite Sheet.
9) 2 Hour Construction: UL System C-AJ-8220; Specified Technologies Inc. SSM Mortar.
b. Uninsulated Metallic Pipe, Conduit, and Tubing:
1) Up to 4 Hour Construction: UL System C-AJ-1739; HoldRite HydroFlame 300 CG (Caulk Grade - Walls or Floors) Silicone Firestop Sealant.
2) 2 and 3 Hour Construction: UL System C-AJ-1696; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
3) 2 Hour Construction: UL System C-AJ-1090; Specified Technologies Inc. SSP Firestop Putty.
4) 2 Hour Construction: UL System C-AJ-1198; Specified Technologies Inc. SIL Silicone Sealant.
5) 2 Hour Construction: UL System C-AJ-1226; Hilti FS-ONE MAX Intumescent Firestop Sealant.
6) 2 Hour Construction: UL System C-AJ-1240; Specified Technologies Inc. LC Endothermic Firestop Sealant.
7) 2 Hour Construction: UL System C-AJ-1425; Hilti CFS-S SIL GG Firestop Silicone Sealant Gun-Grade.

c. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
   1) 2 and 3 Hour Construction: UL System C-AJ-2843; HoldRite HydroFlame Pipe Collar.
   2) 2 Hour Construction: UL System C-AJ-2167; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   3) 2 Hour Construction: UL System C-AJ-2109; Hilti CP 643N/644 Firestop Collar.
   4) 2 Hour Construction: UL System C-AJ-2106; Specified Technologies Inc. SSW Wrap Strips.
   5) 2 Hour Construction: UL System C-AJ-2282; Specified Technologies Inc. SSW Wrap Strips.
   6) 2 Hour Construction: UL System C-AJ-2297; Specified Technologies Inc. SSC Collars.
   7) 2 Hour Construction: UL System C-AJ-2297; Specified Technologies Inc. SSW Wrap Strips.
   8) 2 Hour Construction: UL System C-AJ-2298; Specified Technologies Inc. LCC Intumescent Firestop Collars.
   9) 2 Hour Construction: UL System C-AJ-2588; Specified Technologies Inc. RTC Range-Taking Collar.
   10) 2 Hour Construction: UL System C-AJ-2772; Specified Technologies Inc. SSW Wrap Strips.
   11) 2 Hour Construction: UL System C-BJ-2021; Hilti CP 643N Firestop Collar.

d. Electrical Cables Not In Conduit:
   1) 2 Hour Construction: UL System C-AJ-3213; Specified Technologies Inc. LCC Intumescent Firestop Collars.
   2) 2 Hour Construction: UL System C-AJ-3213; Specified Technologies Inc. SSC Collars.
   3) 2 Hour Construction: UL System W-J-3046; Specified Technologies Inc. SSP Firestop Putty.
   4) 2 Hour Construction: UL System C-AJ-3154; Specified Technologies Inc. SSP Firestop Putty.
   5) 2 Hour Construction: UL System C-AJ-3375; HoldRite HydroFlame 300 CG (Caulk Grade) Silicone Firestop Sealant.
   6) 2 Hour Construction: UL System C-AJ-3216; Hilti CFS-PL Firestop Plug.
   7) 2 Hour Construction: UL System C-AJ-3283; Hilti CFS-SL SK Firestop Sleeve Kit.
   8) 2 Hour Construction: UL System C-AJ-3283; Hilti CFS-SL SK Firestop Sleeve Kit with Hilti CFS-SL GP Gangplate.
   9) 2 Hour Construction: UL System W-J-3198; Hilti CFS-SL RK Retrofit Sleeve Kit for Existing Cables.
   10) 2 Hour Construction: UL System W-J-3199; Hilti CFS-SL SK Firestop Sleeve Kit.

e. Low Voltage Cables Not In Conduit:
   1) 2 Hour Construction: UL System C-AJ-3283; Hilti CP653 Speed Sleeve.
   2) 2 Hour Construction: UL System W-J-3198; Hilti CFS-SL RK Retrofit Sleeve Kit for Existing Cables.

f. Cable Trays with Electrical Cables:
   1) 2 Hour Construction: UL System C-AJ-4094; Hilti CFS-BL Firestop Block.

g. Insulated Pipes:
   1) 2 Hour Construction: UL System C-AJ-5048; Hilti FS-ONE MAX Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 601S Elastomeric Firestop Sealant, CP 604 Self-Leveling Firestop Sealant or CFS-S SIL GG Firestop Silicone Sealant Gun-Grade.
   2) 2 Hour Construction: UL System C-AJ-5087; Specified Technologies Inc. SSS Intumescent Firestop Sealant.
   3) 2 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE IMAX Intumescent Firestop Sealant.

4) 2 Hour Construction: UL System C-AJ-5138; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
5) 2 Hour Construction: UL System C-AJ-5313; Specified Technologies Inc. LC Endothermic Firestop Sealant.
6) 2 Hour Construction: UL System C-AJ-5433; HoldRite HydroFlame 300 CG (Caulk Grade).

h. HVAC Ducts, Uninsulated:
1) 2 Hour Construction: UL System C-AJ-7111; Hilti FS-ONE MAX Intumescent Firestop Sealant.
2) 2 Hour Construction: UL System C-AJ-7224; HoldRite HydroFlame 300 SL (Floors Only), or HoldRite HydroFlame 300 CG (Walls or Floors).
3) 2 Hour Construction: UL System C-AJ-7222; HoldRite HydroFlame 300 CG (Caulk Grade).

3. Penetrations Through Floors By:
a. Multiple Penetrations in Large Openings:
1) 2 Hour Construction: UL System F-A-8012; Hilti CFS-S SIL GG Firestop Silicone Sealant Gun-Grade or CFS-S SIL SL Firestop Silicone Sealant Self-Leveling.

b. Uninsulated Metallic Pipe, Conduit, and Tubing:
1) 2 Hour Construction: UL System F-A-1016; Hilti CP 680-P/M Cast-In Device.
2) 2 Hour Construction: UL System F-A-1110; Specified Technologies Inc. CID Cast-In Device.
3) 2 Hour Construction: UL System F-A-1129; Specified Technologies Inc. Closet Flange Firestop Gasket.

c. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
1) 2 and 3 Hour Construction: UL System F-A-1133; HoldRite HydroFlame HFP-Px, HFP-PxB Cast-In Device.
2) 2 Hour Construction: UL System F-A-2065; Hilti CP 680-P Cast-In Device.
3) 2 Hour Construction: UL System F-A-2213; Hilti CFS-DID Drop-In Device.
4) 2 Hour Construction: UL System F-A-2053; Hilti CP 680-P Cast-In Device.
5) 2 Hour Construction: UL System F-A-2216; Specified Technologies Inc. Closet Flange Firestop Gasket.
6) 2 Hour Construction: UL System F-A-2246; Specified Technologies Inc. CID Cast-In Device.

d. Electrical Cables Not In Conduit:
1) 2 Hour Construction: UL System F-A-3033; Hilti CP 680-P/M Cast-In Device.
2) 2 Hour Construction: UL System F-A-3032; Specified Technologies Inc. Ready Split Sleeve.

e. Low Voltage Cables Not In Conduit:
1) 3 Hour Construction: UL System F-A-3052; HoldRite HydroFlame HFP-Px, HFP-PxB, HFP-Mx, or HFP-MxB Cast-In Device.
2) 2 Hour Construction: UL System F-A-3058; Specified Technologies Inc. EZ-Path Series 44 Fire-Rated Pathway.

f. Electrical Busways:
1) 2 Hour Construction: UL System F-A-6002; Hilti CP 604 Self-Leveling Firestop Sealant.

g. Insulated Pipes:
1) 2 and 3 Hour Construction: UL System F-A-5043; HoldRite HydroFlame HFP-Px, or HFP-PxB Cast-In Device.
2) 2 Hour Construction: UL System F-A-5015; Hilti CP 680-P/M Cast-In Device.
3) 2 Hour Construction: UL System F-A-5017; Hilti CP 680-P/M Cast-In Device.

4) 2 Hour Construction: UL System F-A-5041; Specified Technologies Inc. CID Cast-In Device.
5) 2 Hour Construction: UL System F-A-5045; Specified Technologies Inc. CID Cast-In Device.

4. Penetrations Through Walls By:
   a. Uninsulated Metallic Pipe, Conduit, and Tubing:
      1) 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.
      2) 1 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   b. Electrical Cables Not In Conduit:
      1) 2 Hour Construction: UL System C-AJ-3357; HoldRite HydroFlame 100 Intumescent Firestop Sealant.
      2) 2 Hour Construction: UL System C-AJ-3095; Hilti FS-ONE MAX Intumescent Firestop Sealant.
      3) 2 Hour Construction: UL System W-J-3090; Specified Technologies Inc. SSP Firestop Putty.
      4) 2 Hour Construction: UL System C-AJ-3216; Hilti CFS-PL Firestop Plug.
      5) 2 Hour Construction: UL System W-J-3090; Specified Technologies Inc. SSP Firestop Putty.
      6) 2 Hour Construction: UL System C-AJ-3357; HoldRite HydroFlame 100 Intumescent Firestop Sealant.
      7) 2 Hour Construction: UL System C-AJ-3095; Hilti FS-ONE MAX Intumescent Firestop Sealant.
      8) 2 Hour Construction: UL System C-AJ-3216; Hilti CFS-PL Firestop Plug.
      9) 2 Hour Construction: UL System W-J-3090; Specified Technologies Inc. SSP Firestop Putty.
      10) 2 Hour Construction: UL System W-J-3141; Specified Technologies Inc. Ready-Sleeve.
      11) 2 Hour Construction: UL System W-J-3156; Specified Technologies Inc. Ready Split Sleeve.
      12) 2 Hour Construction: UL System W-J-3182; Specified Technologies Inc. Ready Split Sleeve.
      13) 2 Hour Construction: UL System W-J-3182; Specified Technologies Inc. Ready-Sleeve.
   c. Low Voltage Cables Not In Conduit:
      1) 2 Hour Construction: UL System W-J-3098; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
      2) 2 Hour Construction: UL System W-J-3130; Specified Technologies Inc. EZ-Path Series 22 Fire-Rated Pathway.
      3) 2 Hour Construction: UL System W-J-3138; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
      4) 2 Hour Construction: UL System W-J-3158; Specified Technologies Inc. EZ-Path Series 44 Fire-Rated Pathway.
      5) 2 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE MAX Intumescent Firestop Sealant.
      6) 2 Hour Construction: UL System W-J-3180; Specified Technologies Inc. EZ-Path Series 44 Fire-Rated Pathway.
   d. Insulated Pipes:
      1) 2 Hour Construction: UL System C-AJ-5090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
      2) 2 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE MAX Intumescent Firestop Sealant.

3) 2 Hour Construction: UL System C-AJ-5407; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
4) 1 Hour Construction: UL System C-AJ-5090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
5) 1 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE MAX Intumescent Firestop Sealant.

e. HVAC Ducts, Uninsulated:
1) 2 Hour Construction: UL System W-J-7092; Specified Technologies Inc. FyreFlange HVAC Firestop Angle.
2) 2 Hour Construction: UL System W-J-7109; Hilti FS-ONE MAX Intumescent Firestop Sealant, or CP 606 Flexible Firestop Sealant.

f. HVAC Ducts, Insulated:
1) 2 Hour Construction: UL System W-J-7112; Hilti FS-ONE MAX Intumescent Firestop Sealant.

D. FIRESTOPPING PENETRATIONS THROUGH FRAMED FLOORS

1. Metallic Pipe, Conduit, and Tubing Penetrations in Framed Floors:
a. 1 and 2 Hour Construction: UL System F-C-1177; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
b. 1 Hour Construction: UL System F-C-1053; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
c. 1 Hour Construction: UL System F-C-1162; Specified Technologies Inc. Closet Flange Firestop Gasket.

2. Non-Metallic Pipe, Conduit or Tubing in Framed Floors:
a. 2 Hour Construction: UL System F-C-2020; Specified Technologies Inc. LCC Intumescent Firestop Collars.
b. 2 Hour Construction: UL System F-C-2020; Specified Technologies Inc. SSC collars.
c. 2 Hour Construction: UL System F-C-2348; Specified Technologies Inc. RTC Range-Taking Collar.
d. 2 Hour Construction: UL System F-C-2402; Specified Technologies Inc. Closet Flange Firestop Gasket.
e. 1 and 2 Hour Construction: UL System F-C-2473; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
f. 1 Hour Construction: UL System F-C-2487; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
g. 1 Hour Construction: UL System F-C-2014; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
h. 1 Hour Construction: UL System F-C-2020; Specified Technologies Inc. LCC Intumescent Firestop Collars.
i. 1 Hour Construction: UL System F-C-2020; Specified Technologies Inc. SSC Collars.
j. 1 Hour Construction: UL System F-C-2348; Specified Technologies Inc. RTC Range-Taking Collar.
k. 1 Hour Construction: UL System F-C-2402; Specified Technologies Inc. Closet Flange Firestop Gasket.

3. Electrical Cable in Framed Floors:
a. 1 Hour Construction: UL System F-C-3010; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
b. 1 and 2 Hour Construction: UL System F-C-3121; HoldRite HydroFlame 200 Intumescent Firestop Sealant.

4. Insulated Pipe in Framed Floors:
    a. 2 Hour Construction: UL System F-C-5090; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
    b. 1 Hour Construction: UL System F-C-5043; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
5. FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS
    a. Blank Openings:
        1) 2 Hour Construction: UL System W-L-0020; Specified Technologies Inc. Composite Sheet.
        2) 2 Hour Construction: UL System W-L-0032; Specified Technologies Inc. FP Intumescent Firestop Plug.
        3) 2 Hour Construction: UL System W-L-0038; Specified Technologies Inc. FP Intumescent Firestop Plug.
        4) 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
        5) 1 Hour Construction: UL System W-L-0020; Specified Technologies Inc. Composite Sheet.
        6) 1 Hour Construction: UL System W-L-0032; Specified Technologies Inc. FP Intumescent Firestop Plug.
        7) 1 Hour Construction: UL System W-L-0038; Specified Technologies Inc. FP Intumescent Firestop Plug.
            (a) 2 Hour Construction: UL System W-L-8025; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
        8) 1 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
    b. Penetrations By:
        1) Multiple Penetrations in Large Openings:
            (a) 2 Hour Construction: UL System W-L-1408; Hilti FS-ONE MAX Intumescent Firestop Sealant.
            (b) 2 Hour Construction: UL System W-L-8013; Hilti CFS-BL Firestop Block.
            (c) 2 Hour Construction: UL System W-L-8025; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
            (d) 2 Hour Construction: UL System W-L-8050; Specified Technologies Inc. SSB Intumescent Firestop Pillows.
            (e) 2 Hour Construction: UL System W-L-8071; Hilti FS-ONE MAX Intumescent Firestop Sealant.
            (f) 2 Hour Construction: UL System W-L-8073; Specified Technologies Inc. Composite Sheet.
            (g) 2 Hour Construction: UL System W-L-8079; Hilti FS-ONE MAX Intumescent Firestop Sealant.
            (h) 1 and 2 Hour Construction: UL System W-L-1568; HoldRite HydroFlame 100 Intumescent Firestop Sealant.
            (i) 1 Hour Construction: UL System W-L-1408; Hilti FS-ONE MAX Intumescent Firestop Sealant.
            (j) 1 Hour Construction: UL System W-L-8013; Hilti CFS-BL Firestop Block.
            (k) 1 Hour Construction: UL System W-L-8025; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
            (l) 1 Hour Construction: UL System W-L-8050; Specified Technologies Inc. SSB Intumescent Firestop pillows.
            (m) 1 Hour Construction: UL System W-L-8071; Hilti FS-ONE MAX Intumescent Firestop Sealant.
            (n) 1 Hour Construction: UL System W-L-8073; Specified Technologies Inc. Composite Sheet.
            (o) 1 Hour Construction: UL System W-L-8079; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2) Uninsulated Metallic Pipe, Conduit, and Tubing:
   (a) 2 Hour Construction: UL System W-L-1033; Specified Technologies Inc. SIL Silicone Sealant.
   (b) 2 Hour Construction: UL System W-L-1042; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
   (c) 2 Hour Construction: UL System W-L-1049; Specified Technologies Inc. SSS Intumescent Firestop Sealant.
   (d) 2 Hour Construction: UL System W-L-1090; Specified Technologies Inc. LC Endothermic Firestop Sealant.
   (e) 2 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   (f) 2 Hour Construction: UL System W-L-1164; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   (g) 2 Hour Construction: UL System W-L-1222; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
   (h) 2 Hour Construction: UL System W-L-1477; Specified Technologies Inc. EZ Firestop Grommet.
   (i) 2 Hour Construction: UL System W-L-1506; Hilti CFS-D Firestop Cable Disc.
   (j) 1 and 2 Hour Construction: UL System W-L-1558; HoldRite HydroFlame 100 Intumescent Firestop Sealant.
   (k) 1 and 2 Hour Construction: UL System W-L-1558; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
   (l) 1 Hour Construction: UL System W-L-1042; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
   (m) 1 Hour Construction: UL System W-L-1049; Specified Technologies Inc. SSS Intumescent Firestop Sealant.
   (n) 1 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   (o) 1 Hour Construction: UL System W-L-1090; Specified Technologies Inc. LC Endothermic Firestop Sealant.
   (p) 1 Hour Construction: UL System W-L-1164; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   (q) 1 Hour Construction: UL System W-L-1222; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
   (r) 1 Hour Construction: UL System W-L-1506; Hilti CFS-D Firestop Cable Disc.
3) Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
   (a) 2 Hour Construction: UL System W-L-2048; Specified Technologies Inc. SSW Wrap Strips.
   (b) 2 Hour Construction: UL System W-L-2074; Specified Technologies Inc. SSC Collars.
   (c) 2 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.
   (d) 2 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   (e) 2 Hour Construction: UL System W-L-2237; Specified Technologies Inc. LCC Intumescent Firestop Collars.
   (f) 2 Hour Construction: UL System W-L-2241; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
   (g) 2 Hour Construction: UL System W-L-2243; Specified Technologies Inc. SSW Wrap Strips.
   (h) 2 Hour Construction: UL System W-L-2493; Specified Technologies Inc. RTC Range-Taking Collar.

(i) 1 and 2 Hour Construction: UL System W-L-2710; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
(j) 1 Hour Construction: UL System W-L-2048; Specified Technologies Inc. SSW Wrap Strips.
(k) 1 Hour Construction: UL System W-L-2074; Specified Technologies Inc. SSC Collars.
(l) 1 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.
(m) 1 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
(n) 1 Hour Construction: UL System W-L-2237; Specified Technologies Inc. LCC Intumescent Firestop Collars.
(o) 1 Hour Construction: UL System W-L-2241; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
(p) 1 Hour Construction: UL System W-L-2243; Specified Technologies Inc. SSW Wrap Strips.
(q) 1 Hour Construction: UL System W-L-2493; Specified Technologies Inc. RTC Range-Taking Collar.

4) Electrical Cables Not In Conduit:
(a) 2 Hour Construction: UL System W-L-3024; Specified Technologies Inc. SSP Firestop Putty.
(b) 2 Hour Construction: UL System W-L-3065; Hilti FS-ONE MAX Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
(c) 2 Hour Construction: UL System W-L-3076; Specified Technologies Inc. SSS Intumescent Firestop Sealant.
(d) 2 Hour Construction: UL System W-L-3084; Specified Technologies Inc. SSB Intumescent Firestop Pillows.
(e) 2 Hour Construction: UL System W-L-3135; Specified Technologies Inc. SSP Firestop Putty.
(f) 2 Hour Construction: UL System W-L-3169; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
(g) 2 Hour Construction: UL System W-L-3303; Specified Technologies Inc. Ready Split Sleeve.
(h) 2 Hour Construction: UL System W-L-3350; Specified Technologies Inc. LC Endothermic Firestop Sealant.
(i) 2 Hour Construction: UL System W-L-3357; Specified Technologies Inc. FP Intumescent Firestop Plug.
(j) 2 Hour Construction: UL System W-L-3358; Specified Technologies Inc. Ready Split Sleeve.
(k) 2 Hour Construction: UL System W-L-3358; Specified Technologies Inc. Ready-Sleeve.
(l) 2 Hour Construction: UL System W-L-3374; Specified Technologies Inc. FP Intumescent Firestop Plug.
(m) 2 Hour Construction: UL System W-L-3376; Specified Technologies Inc. Ready-Sleeve.
(n) 2 Hour Construction: UL System W-L-3395; Hilti CFS-SL SK Firestop Sleeve Kit.
(o) 2 Hour Construction: UL System W-L-3395; Hilti CFS-SL SK Firestop Sleeve Kit with Hilti CFS-SL GP Gangplate.
(p) 2 Hour Construction: UL System W-L-3414; Hilti CFS-D Firestop Cable Disc.
(q) 1 and 2 Hour Construction: UL System W-L-3453; HoldRite HydroFlame 200 Intumescent Firestop Sealant.

(r) 1 Hour Construction: UL System W-L-3024; Specified Technologies Inc. SSP Firestop Putty.
(s) 1 Hour Construction: UL System W-L-3065; Hilti FS-ONE MAX Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
(t) 1 Hour Construction: UL System W-L-3076; Specified Technologies Inc. SSS Intumescent Firestop Sealant.
(u) 1 Hour Construction: UL System W-L-3084; Specified Technologies Inc. SSB Intumescent Firestop Pillows.
(v) 1 Hour Construction: UL System W-L-3135; Specified Technologies Inc. SSP Firestop Putty.
(w) 1 Hour Construction: UL System W-L-3169; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
(x) 1 Hour Construction: UL System W-L-3303; Specified Technologies Inc. Ready Split Sleeve.
(y) 1 Hour Construction: UL System W-L-3350; Specified Technologies Inc. LC Endothermic Firestop Sealant.
(z) 1 Hour Construction: UL System W-L-3357; Specified Technologies Inc. FP Intumescent Firestop Plug.
(aa) 1 Hour Construction: UL System W-L-3358; Specified Technologies Inc. Ready Split Sleeve.
(bb) 1 Hour Construction: UL System W-L-3358; Specified Technologies Inc. Ready-Sleeve.
(cc) 1 Hour Construction: UL System W-L-3374; Specified Technologies Inc. FP Intumescent Firestop Plug.
(dd) 1 Hour Construction: UL System W-L-3376; Specified Technologies Inc. Ready-Sleeve.
(ee) 1 Hour Construction: UL System W-L-3414; Hilti CFS-D Firestop Cable Disc.

5) Low Voltage Cable Not In Conduit:
(a) 2 Hour Construction: UL System W-L-3218; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
(b) 2 Hour Construction: UL System W-L-3255; Specified Technologies Inc. EZ-Path Series 22 Fire-Rated Pathway.
(c) 2 Hour Construction: UL System W-L-3256; Specified Technologies Inc. EZ-Path Series 22 Fire-Rated Pathway.
(d) 2 Hour Construction: UL System W-L-3265; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
(e) 2 Hour Construction: UL System W-L-3306; Specified Technologies Inc. EZ-Path Series 44 Fire-Rated Pathway.
(f) 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
(g) 2 Hour Construction: UL System W-L-3369; Specified Technologies Inc. EZ Firestop Grommet.
(h) 2 Hour Construction: UL System W-L-3370; Specified Technologies Inc. EZ Firestop Grommet.
(i) 2 Hour Construction: UL System W-L-3377; Specified Technologies Inc. EZ-Path Series 22 Fire-Rated Pathway.
(j) 2 Hour Construction: UL System W-L-3377; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
(k) 2 Hour Construction: UL System W-L-3378; Specified Technologies Inc. EZ Firestop Grommet.

(l) 2 Hour Construction: UL System W-L-3379; Specified Technologies Inc. EZ Firestop Grommet.
(m) 2 Hour Construction: UL System W-L-3390; Specified Technologies Inc. EZ-Path Series 44 Fire-Rated Pathway.
(n) 2 Hour Construction: UL System W-L-3393; Hilti CFS-SL RK Retrofit Sleeve Kit for Existing Cables.
(o) 2 Hour Construction: UL System W-L-3395; Hilti CP653 Speed Sleeve.
(p) 1 Hour Construction: UL System W-L-3265; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
(q) 1 Hour Construction: UL System W-L-3218; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
(r) 1 Hour Construction: UL System W-L-3255; Specified Technologies Inc. EZ-Path Series 22 Fire-Rated Pathway.
(s) 1 Hour Construction: UL System W-L-3256; Specified Technologies Inc. EZ-Path Series 22 Fire-Rated Pathway.
(t) 1 Hour Construction: UL System W-L-3265; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
(u) 1 Hour Construction: UL System W-L-3306; Specified Technologies Inc. EZ-Path Series 44 Fire-Rated Pathway.
(v) 1 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
(w) 1 Hour Construction: UL System W-L-3369; Specified Technologies Inc. EZ Firestop Grommet.
(x) 1 Hour Construction: UL System W-L-3370; Specified Technologies Inc. EZ Firestop Grommet.
(y) 1 Hour Construction: UL System W-L-3377; Specified Technologies Inc. EZ-Path Series 22 Fire-Rated Pathway.
(z) 1 Hour Construction: UL System W-L-3377; Specified Technologies Inc. EZ-Path Series 33 Fire-Rated Pathway.
(aa) 1 Hour Construction: UL System W-L-3378; Specified Technologies Inc. EZ Firestop Grommet.
(bb) 1 Hour Construction: UL System W-L-3379; Specified Technologies Inc. EZ Firestop Grommet.
(cc) 1 Hour Construction: UL System W-L-3390; Specified Technologies Inc. EZ-Path Series 44 Fire-Rated Pathway.
(dd) 1 Hour Construction: UL System W-L-3393; Hilti CFS-SL RK Retrofit Sleeve Kit for Existing Cables.

6) Cable Trays with Electrical Cables:
(a) 2 Hour Construction: UL System W-L-4008; Specified Technologies Inc. SSB Intumescent Firestop Pillows.
(b) 2 Hour Construction: UL System W-L-4011; Hilti CFS-BL Firestop Block.
(c) 2 Hour Construction: UL System W-L-4060; Hilti FS-ONE MAX Intumescent Firestop Sealant.
(d) 1 Hour Construction: UL System W-L-4008; Specified Technologies Inc. SSB Intumescent Firestop Pillows.
(e) 1 Hour Construction: UL System W-L-4011; Hilti CFS-BL Firestop Block.
(f) 1 Hour Construction: UL System W-L-4060; Hilti FS-ONE MAX Intumescent Firestop Sealant.

7) Insulated Pipes:
   (a) 2 Hour Construction: UL System W-L-5014; Specified Technologies Inc. SSS Intumescent Firestop Sealant.
   (b) 2 Hour Construction: UL System W-L-5028; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   (c) 2 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant.
   (d) 2 Hour Construction: UL System W-L-5121; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
   (e) 2 Hour Construction: UL System W-L-5273; Specified Technologies Inc. LC Endothermic Firestop Sealant.
   (f) 2 Hour Construction: UL System W-L-5298; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
   (g) 1 Hour Construction: UL System W-L-5014; Specified Technologies Inc. SSS Intumescent Firestop Sealant.
   (h) 1 Hour Construction: UL System W-L-5028; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   (i) 1 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant.
   (j) 1 Hour Construction: UL System W-L-5121; Specified Technologies Inc. LCI Intumescent Firestop Sealant.
   (k) 1 Hour Construction: UL System W-L-5273; Specified Technologies Inc. LC Endothermic Firestop Sealant.
   (l) 1 Hour Construction: UL System W-L-5298; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
   (m) 1 and 2 Hour Construction: UL System W-L-5357; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
8) HVAC Ducts, Insulated:
   (a) 2 Hour Construction: UL System W-L-7156; Hilti FS-ONE MAX Intumescent Firestop Sealant.
   (b) 2 Hour Construction: UL System W-L-7164; Specified Technologies Inc. FyreFlange HVAC Firestop Angle.
   (c) 2 Hour Construction: UL System W-L-7238; Specified Technologies Inc. FyreFlange HVAC Firestop Angle.
   (d) 1 Hour Construction: UL System W-L-7164; Specified Technologies Inc. FyreFlange HVAC Firestop Angle.
   (e) 1 Hour Construction: UL System W-L-7238; Specified Technologies Inc. FyreFlange HVAC Firestop Angle.
   (f) 1 Hour Construction: UL System W-L-7156; Hilti FS-ONE MAX Intumescent Firestop Sealant.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
B. Remove incompatible materials that could adversely affect bond.
C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.

C. Do not cover installed firestopping until inspected by authorities having jurisdiction.

D. Install labeling required by code.

E. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. For continuous penetrations, install labels at 10 feet on center.

3.04 FIELD QUALITY CONTROL

A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.

B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 07 84 00

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-sag gunnable joint sealants.
   1. Exterior applications
      a. Joints in masonry, including architectural precast.
      b. Joints around hollow metal.
      c. Miscellaneous joints where “sealant” or “caulk/caulking” is indicated on drawings.
      d. Joints around mechanical, electrical and architectural penetrations of exterior masonry skin.
      e. Installation of sealant on masonry quality control panel for color match and adhesion verification by means of an adhesion test.
      f. Removal and replacement of existing sealants.
   2. Interior applications
      a. Note: Sealant on materials to be painted will be installed after painting is completed and shall match paint color. A “sacrificial” backer rod shall be installed prior to painting to protect joints from paint over spray. This backer rod may be pushed into the joint or removed prior to installation of final backer rod and sealant.
      b. Interior joints in masonry.
      c. Interior joints around hollow metal, including joint between hollow metal and hard surface flooring.
      d. Joints in slabs and at edges where painted, exposed or sealed concrete is shown on Drawings.
      e. Miscellaneous joints where “sealants” or “caulk/caulking” is indicated on Drawings.

B. Self-leveling pourable joint sealants.
C. Joint backings and accessories.
D. Owner-provided field quality control.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, which includes the following.
   1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
   2. List of backing materials approved for use with the specific product.
   3. Substrates product is known to satisfactorily adhere to and with which it is compatible.
   4. Substrates product should not be used on.
C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
D. Samples for Verification: Where custom sealant color is specified, submit at least two physical samples for verification of each color to match adjacent materials of each required sealant.
E. Installation Plan: Submit at least four weeks prior to start of installation.
F. Preinstallation Field Adhesion Test Plan: Submit at least two weeks prior to start of installation.
G. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
H. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.
I. Installation Log: Submit filled out log for each length or instance of sealant installed.
J. Field Quality Control Log: Submit filled out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.

B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

C. Installation Plan: Include schedule of sealed joints, including the following.

1. Installation Log Form: Include the following data fields, with known information filled out.
    a. Date of installation.
    b. Name of installer.
    c. Actual joint width; provide space to indicate maximum and minimum width.
    d. Actual joint depth to face of backing material at centerline of joint.
    e. Air temperature.

D. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.

1. Identification of testing agency.
2. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.
    a. Test date.
    b. Date of test.
    c. Copy of test method documents.
    d. Age of sealant upon date of testing.
    e. Test results, modeled after the sample form in the test method document.
    f. Indicate use of photographic record of test.

E. Owner will employ an independent testing agency to perform the field quality control inspection and testing as referenced in PART 3 of this section and as follows, to prepare and submit the field quality control plan and log, and to provide recommendations of remedies in the case of failure.

F. Field Quality Control Plan:

1. Visual inspection of entire length of sealant joints.
2. Destructive field adhesion testing of sealant joints, except interior acrylic latex sealant.
    a. For each different sealant and substrate combination, allow for one test every 100 feet (30 meters) in the first 1000 linear feet (305 linear meters), and one test per 1000 linear feet (305 meters) thereafter, or once per floor on each elevation.
    b. If any failures occur in the first 1000 linear feet (305 linear meters), continue testing at frequency of one test per 500 linear feet (152 linear meters) at no extra cost to Owner.
3. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.

G. Field Adhesion Test Procedures:

1. Allow sealants to fully cure as recommended by manufacturer before testing.
2. Have a copy of the test method document available during tests.
3. Take photographs or make video records of each test, with joint identification provided in the photos/videos; for example, provide small erasable whiteboard positioned next to joint.
4. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
5. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.

6. Deliver the samples removed during destructive tests in separate sealed plastic bags, identified with project, location, test date, and test results, to Owner.
7. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

H. Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Destructive Tail Procedure.
1. Sample: At least 18 inch (457 mm) long.
2. Minimum Elongation Without Adhesive Failure: Consider the tail at rest, not under any elongation stress; multiply the stated movement capability of the sealant in percent by two; then multiply 1 inch (25 mm) by that percentage; if adhesion failure occurs before the "1 inch mark" is that distance from the substrate, the test has failed.
3. If either adhesive or cohesive failure occurs prior to minimum elongation, take necessary measures to correct conditions and re-test; record each modification to products or installation procedures.
4. Record results on Field Quality Control Log.
5. Repair failed portions of joints.

I. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or other applicable method as recommended by manufacturer.

1.04 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Correct defective work within a five year period after Date of Substantial Completion.

C. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Non-Sag Sealants:
1. Permits application in joints on vertical surfaces without sagging or slumping.
a. BASF: www.master-builders-solutions.com.
b. Pecora Corporation: www.pecora.com.
c. SIKA: www.usa.sika.com.
d. TREMCO: www.tremcosealants.com.
e. Dow; www.dow.com.
f. GE; www.siliconeforbuilding.com.

B. Self-Leveling Sealants:
1. SelPourable or self-leveling sealant that has sufficient flow to form a smooth, level surface when applied in a horizontal joint.
a. BASF: www.master-builders-solutions.com.
b. Pecora Corporation: www.pecora.com.
c. SIKA: www.usa.sika.com.
d. TREMCO: www.tremcosealants.com

C. One or two-component, nonsag elastomeric sealant with a shoe hardness of 50 +/- 5.
1. BASF: www.master-builders-solutions.com.
2. Pecora Corporation: www.pecora.com.

2.02 JOINT SEALANT APPLICATIONS

A. Scope:
1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
a. Wall expansion and control joints.
b. Joints between door, window, and other frames and adjacent construction.

c. Joints between different exposed materials.
d. Openings below ledge angles in masonry.
e. Other joints indicated below.

2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
a. Joints between door, window, and other frames and adjacent construction.
b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
c. Other joints indicated below and as shown on drawings.

3. Do not seal the following types of joints.
a. Intentional weep holes in masonry.
b. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
d. Joints where installation of sealant is specified in another section.
e. Joints between suspended panel ceilings/grid and walls.

2.03 NON-SAG JOINT SEALANTS

A. Exterior Use: Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion.
1. Movement Capability: +/- 25%, minimum.
2. Non-Staining To Porous Stone: Non-staining to light-colored natural stone when tested in accordance with ASTM C1248.
3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
4. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
5. Custom Colors: Match adjacent finished surfaces.
6. Cure Type: Single-component, neutral moisture curing.
7. Service Temperature Range: Minus 65 to 180 degrees F (Minus 54 to 82 degrees C).
8. Products:
a. Dow; DOWSIL 790
b. GE Silicone; SCS2700 LM
c. Pecora Corporation; 890 or 890 FTS
d. SIKA; Sikalsil WS-290 FPS
e. Tremco; Spectrum 1

B. Exterior Use: Silyl-Terminated Polyether (STPE): ASTM C920, Grade NS, Uses M and A; single component; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 12-1/2 percent, minimum
2. Hardness Range: 25 to 30, Shore A, when tested in accordance with ASTM C661.
3. Custom Colors: Match adjacent finished surfaces.
4. Color: To be selected by Architect from manufacturer's standard range.
5. Service Temperature Range: Minus 40 to 180 degrees F (Minus 40 to 82 degrees C).
6. Products:
a. BASF; MasterSeal NP 150/Np100
b. Pecora Corporation; DynaFlex SC (Security Sealant)
c. SIKA; SIKAFLEX 2-C
d. Tremco; Dymonic FC

C. Interior Use: Silyl-Terminated Polyether (STPE): ASTM C920, Grade NS, Uses M and A; single component; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 12-1/2 percent, minimum
2. Hardness Range: 25 to 30, Shore A, when tested in accordance with ASTM C661.
3. Custom Colors: Match adjacent finished surfaces.
4. Service Temperature Range: Minus 40 to 180 degrees F (Minus 40 to 82 degrees C).

5. Products:
    a. BASF; MasterSeal NP 150/Np100
    b. Pecora Corporation; DynaFlex SC (Security Sealant)
    c. SIKA; SIKAFLEX 2-C
    d. Tremco; Dymonic FC

D. Interior Use: Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 25 percent, minimum.
2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
3. Custom Colors: Match adjacent finished surfaces.
4. Service Temperature Range: Minus 40 to 180 degrees F (Minus 40 to 82 degrees C).
5. Products:
    a. BASF; MasterSeal: NP2
    b. Pecora Corporation; DynaTrol II
    c. SIKA; SIKAFLEX 2-C
    d. Tremco; DYMERIC 240/240FC

2.04 SELF-LEVELING SEALANTS

A. Self-Leveling Polyurethane Sealant for Horizontal Expansion Joints: ASTM C920, Grade M; multi-component; explicitly approved by manufacturer for horizontal expansion joints.
1. Movement Capability: Plus and minus 25 percent, minimum.
2. Hardness Range: 30 to 35, Shore A, when tested in accordance with ASTM C661.
3. Color: To be selected by Architect from manufacturer's standard range.
4. Tensile Strength: 150 psi (1.34 MPa) in accordance with ASTM D412.
5. Products:
    a. Pecora Corporation; DynaTrol II-SG (Slope Grade)
    b. SIKA; SIKAFLEX 2c SL
    c. BASF; MasterSeal SL2
    d. Tremco; THC/900/901

2.05 ACCESSORIES

A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specified sealant, and recommended by backing and sealant manufacturers for specific application.
1. Joints not subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type O - Open Cell Polyurethane
2. Joints Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
3. Open Cell: 40 to 50 percent larger in diameter than joint width.
4. Closed Cell and Bi-Cellular: 25 to 33 percent larger in diameter than joint width.

B. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.

C. Joint Cleaner: Non-corrosive and non-staining type, type recommended by sealant manufacturer; compatible with joint forming materials.

D. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Verify that backer rods are of the correct size.

D. Pre-installation Adhesion Testing: Install a sample for each test location indicated in the test plan.
1. Test each sample as specified in PART 1 under QUALITY ASSURANCE article.
2. Notify Architect of date and time that tests will be performed, at least 7 days in advance.
3. Record each test on Preinstallation Adhesion Test Log as indicated.

4. If any sample fails, review products and installation procedures, consult manufacturer, or take whatever other measures are necessary to ensure adhesion; re-test in a different location; if unable to obtain satisfactory adhesion, report to Architect.
5. After completion of tests, remove remaining sample material and prepare joint for new sealant installation.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.
B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.
E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in inconspicuous area to verify that it does not stain or discolor slab.

3.03 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
B. Perform acoustical sealant application work in accordance with ASTM C919.
C. Install bond breaker backing tape where backer rod cannot be used.
D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
F. Non-Sag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
G. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.

3.04 EXISTING WORK

A. Mechanically remove existing sealants.
B. Clean joint surfaces of residual sealant and other contaminates capable of affecting sealant bond to joint surface by mechanical means.
C. Allow joint surfaces to dry before installing new sealant.

3.05 FIELD QUALITY CONTROL

A. Owner will employ an independent testing agency to perform field quality control inspection and testing as specified in PART 1 under QUALITY ASSURANCE article.
B. Destructive Adhesion Testing: If there are any failures in first 1000 linear feet (300 linear m), notify Architect immediately.
C. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.
D. Repair destructive test location damage immediately after evaluation and recording of results.
E. Provide free access to construction operations at project site and cooperate with appointed firm.
F. Special Inspection
    1. Special Inspection shall be performed by qualified parties as specified herein, and in accordance with the provisions of Section 01 4533.
    2. The Owner will provide the following tests and inspections:
        a. Periodic Inspections of Continuous Air Barrier installation verification.
        b. Verify air barrier is installed per manufacturers recommendations.

c. Periodic field inspection of the continuous air barrier materials and assemblies shall be conducted during construction while the continuous air barrier is still accessible for inspection and repair to verify and document compliance, as it applies, with the requirements of:
1) ASTM E2178, ASTM E2357, ASTM E1677, ASTM E1680, ASTM E283

3. Provide a written report(s) documenting the continuous air barrier inspection per specification section 01 45 16.

G. Contractor to correct any deficiencies noted in Special Inspection reports.

3.06 POST-OCCUPANCY

A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width; i.e., at low temperature in the thermal cycle. Report failures immediately and repair.

END OF SECTION 07 92 00

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-fire-rated hollow metal frames.
B. Hollow metal frames for wood doors.
C. Fire-rated hollow metal frames as scheduled and/or noted on the Code Plans.
D. Hollow metal borrowed lites glazing frames.
E. DE Series double egress HM frames for doors swings over 90°.
F. Provide equal rabbit door frames.
G. Accessories, including glazing.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
C. Shop Drawings:
   1. Elevations of each door design.
   2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of accessories.
   8. Details of molding, removable stops, and glazing.
   9. Detail of conduit and preparations for power, signal, and control systems.
   10. Rating of doors and frames as noted on door/opening schedule and/or Code Plan.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: https://steeldoor.org/sdi-certified.
B. Obtain hardware templates from hardware supplier (Section 08 71 00) and obtain necessary hardware for factory application.
C. Where noted on Door Schedule, provide nationally recognized testing agency label of proper classification. Label requirements take precedence over conflicting details. Advise the Architect of any conflict before fabricating work on that item is started.
D. Maintain at project site copies of reference standards relating to installation of products specified.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.
C. Storage at jobsite:
   1. Store frames on pallets, under waterproof cover.
   2. Do not deliver doors until they can be stored inside.
      a. Store doors under cover in a dry area with doors set upright with ¼ inch spacers between doors. Keep doors at least 4” above floors.
   3. Materials that are rusted prior to installation may be rejected.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hollow Metal Doors and Frames:
   1. Steelcraft, an Allegion brand: www.allegion.com.
   2. Equivalent products by other manufacturer's are acceptable.

2.02 PERFORMANCE REQUIREMENTS

A. Requirements for Hollow Metal Doors and Frames:
   1. Steel Sheet: Comply with one or more of the following requirements; galvannealed steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
   2. Accessibility: Comply with ICC A117.1 and ADA Standards.
   3. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
   4. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
      a. All doors to have minimum 16-gauge lock reinforcement and either continuous 14-gauge hinge rail or minimum 8-gauge plate hinge reinforcement.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL FRAMES

A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

B. Frame Finish: Factory primed and field finished.

C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
   1. Frame Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
   2. Frame Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
   3. Frame Finish: Factory primed and field finished.

D. Door Frames, Fire-Rated: Full profile/continuously welded type.
   1. Fire Rating: Same as door, labeled.
   2. Frame Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
   3. Frame Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
   4. Frame Finish: Factory primed and field finished.

E. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.

F. Hinge reinforcements to have 10 gauge straps welded directly above and below each hinge pocket.

2.04 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.05 ACCESSORIES

A. Glazing: As specified in Section 08 80 00, factory installed.

B. Astragals and Edges for Double Doors: Pairs of door astragals, and door edge sealing and protection devices.
   1. UL listed products in compliance with requirements of authorities having jurisdiction.
   2. Provide surface mounted astragal to cover or fill space for full door height between pair of doors or door and adjacent jamb.
   3. Edge Type: Beveled edge
   4. Material: Manufacturers standard.
   5. Metal Finish: Beige powder coating.

C. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.

D. Grout for Interior Frames: Mortar grout complying with ASTM C476 with maximum slump of 4 inches (102 mm) as measured in accordance with ASTM C143/C143M for hand troweling in place; plaster grout and thinner pumpable grout are prohibited.

E. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
F. Temporary Frame Spreaders: Provide for factory- or shop-assembled attached to feet of jambs.

2.06 ELECTRICAL REQUIREMENTS

A. Coordinate electrical requirements for doors and frames. Make provisions for installation of electrical items arranged so that wiring can be readily removed and replaced.
B. Doors with electric hinges:
   1. Furnish conduit raceway to permit wiring from electric door hardware.
   2. Hinge locations: Provide electric hinge at intermediate or center location.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that opening sizes and tolerances are acceptable.
C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 PREPARATION

3.03 INSTALLATION

A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
B. Coordinate frame anchor placement with wall construction.
   1. At steel columns and/or concrete surfaces, install sub-frame or rough bucks as specified. At steel columns use 5/16" diameter self-tapping metal screws and at concrete use expansion bolts of the same diameter. Install frame to sub-frame and/or rough buck with countersunk self-tapping metal screws. Fill screw holes with a suitable metallic filler, sand and prime.
   2. All field splices to be welded and filled with body putty and ground smooth, no exposed screw heads will be accepted. Locate splices where shown on final reviewed shop drawings.
C. Grout interior frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
D. Insulate exterior frames with expanding foam insulation.
E. Install door hardware as specified in Section 08 71 00.
   1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.
   2. For all attachments including removable stops, use flat head self-tapping screws. Drill and tap in the field for surface mounted closers, brackets, rim exit devices, door holders, and other surface hardware. At horizontal exterior surfaces, set screws with neoprene gaskets or set with caulking compound under screw head and wipe clean.
F. Coordinate installation of electrical connections to electrical hardware items.

3.04 TOLERANCES

A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
B. Maximum Diagonal Distortion: 1/16 inch (1.6 mm) measured with straight edge, corner to corner.

3.05 ADJUSTING

A. Adjust for smooth and balanced door movement.

3.06 SCHEDULE

A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION 08 11 13

SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Solid core flush wood doors.
B. Rated doors as noted on opening schedule and/or Code Plan.
C. Factory finished doors.
D. Factory prefiting of doors to frames.
E. Factory premachining for hardware.
F. Glazing stops and preparation of doors to receive glazing.
G. Glazing kits for rated doors.
H. Transom panels.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
D. Samples: Submit two samples of door veneer, 8 by 10 inches (203.2 by 254 mm) in size illustrating wood grain, stain color, and sheen.
E. Specimen lifetime warranty.

1.03 QUALITY ASSURANCE

A. Maintain one copy of the specified door quality standard on site for review during installation and finishing.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity at occupancy levels during remainder of construction period.
B. Package, deliver and store doors in accordance with specified quality standard.
C. Accept doors on site in manufacturer's packaging, and inspect for damage.
D. Protect doors with manufacturer's standard plastic bags, stretch wrap, or cardboard cartons. ; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges if stored more than one week, and break seal on site to permit ventilation.
E. Mark each door on top rail with opening number used on Shop Drawings.

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Manufacturer Warranty: Provide manufacturer's warranty on interior doors for the life of the installation. Complete forms in Owner's name and register with manufacturer.
    1. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Wood Veneer Faced Doors:
    1. Masonite Architectural; Marshfield-Algoma: www.architectural.masonite.com.
    2. VT Industries, Inc: www.vtindustries.com.

2.02 DOORS AND PANELS

A. Doors:
    1. Quality Standard: Premium Grade, Heavy Duty performance, in accordance with WDMA I.S. 1A.
        a. Construction: Five plies. Stiles and rails are bonded to core, and then entire unit is abrasive planed before veneering.
    2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.

B. Interior Doors: 1-3/4 inches (44 mm) thick unless otherwise indicated; flush construction.
   1. Provide solid core doors at each location.
   2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) labeled without any visible seals when door is open.
   3. Smoke and Draft Control Doors: In addition to required fire rating, provide flush wood door assemblies in compliance with WDMA I.S. 1A requirements for "S" label; no additional gasketing or edge sealing allowed.
   4. Wood veneer facing with factory transparent finish as indicated on the Interior Material Finish/Color Schedule on the drawings..

C. Transom Panels: Same construction and finish as door; same performance rating as door.

2.03 DOOR AND PANEL CORES

A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.

B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.04 DOOR FACINGS

A. Veneer Facing for Transparent Finish: Species as specified above, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.

B. Veneer Facing for Transparent Finish: Species as specified above, veneer grade in accordance with quality standard indicated, comb grain (only red and white oak), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
   1. Transoms: Continuous match to doors.

C. Facing Adhesive: Type I - waterproof.

2.05 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.

B. Cores Constructed with stiles and rails:
   1. Provide solid blocks at lock edge and top of door for closer for hardware reinforcement.
   2. Provide solid blocking for other throughbolted hardware.

C. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.

D. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

E. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.

F. Clearances at door sills:
   1. Where no threshold is used - 5/8" maximum to finish floor surface.
   2. Where polymer threshold at toilet room doors is used - 1/4" maximum between door and threshold.
   3. Where no threshold is used at toilet stall or single stall toilet rooms - 1/4" maximum to finish floor surface.
   4. Where threshold is used - 1/4" maximum between door and threshold.
   5. Where required for hardware operation - as recommended by hardware manufacturer.

G. Provide edge clearances in accordance with the quality standard specified.

2.06 FINISHES - WOOD VENEER DOORS

A. Finish work in accordance with WDMA I.S. 1A for grade specified and as follows:
   1. Transparent:
      a. Factory finish to be water-based stain and ultraviolet (UV) cured polyurethane sealer to comply with EPA Title 5 guidelines for Volatile Organic Compound (VOC) emissions limitations.
      b. Stain Color: See Interior Material Finish/Color Schedule on drawings
      c. Sheen: Satin.

2. Factory finish doors in accordance with approved sample.
3. Seal door top edge with color sealer to match door facing.

2.07 ACCESSORIES

A. Hollow Metal Door Frames: See Section 08 11 13.

B. Fire Rated Door Window Frames: Door window frames with glazing securely fastened within door opening.
   1. Size: As indicated on drawings.
   2. Frame Material: 18 gauge, 0.0478 inch (1.21 mm), galvanized steel.
      a. Veneer wrapped: Species to match doors.

C. Glazing: See Section 08 80 00.

D. Non Rated and 20 Minute Glazing Stops: Wood, of same species as door facing, mitered corners; prepared for countersink style tamper proof screws.

E. Astragals and Edges for Double Doors: Pairs of doors astragals, and door edge sealing and protection devices.
   1. UL listed products in compliance with requirements of authorities having jurisdiction.
   2. Provide surface mounted astragal to cover or fill space for full door height between pair of doors or door and adjacent jamb.
   3. Astragal Type: Split, two parts, and with automatic locking, cutouts for other door hardware, and sealing gasket.

F. Door Hardware: See Section 08 71 00.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work, including humidity levels as recommended by door manufacturer.

B. Verify that opening sizes and tolerances are acceptable.

C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

A. Install doors in accordance with manufacturer's instructions and specified quality standard.
   1. Install fire-rated doors in accordance with NFPA 80 requirements.

B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.

C. Field-Finished Doors: Trimming to fit is acceptable.
   1. Adjust width of non-rated doors by cutting equally on both jamb edges.
   2. Trim maximum of 3/4 inch (19 mm) off bottom edges.
   3. Trim fire-rated doors in strict compliance with fire rating limitations.

D. Use machine tools to cut or drill for hardware.

E. Coordinate installation of doors with installation of frames and hardware.

F. Coordinate installation of glazing.

3.03 TOLERANCES

A. Comply with specified quality standard for fit and clearance tolerances.

B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

A. Adjust doors for smooth and balanced door movement.

3.05 SCHEDULE

A. See Door and Frame Schedule.

END OF SECTION 08 14 16

SECTION 08 31 00
ACCESS PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall and ceiling mounted access panel.
B. Fire rating of access panels as indicated on the Code Plan(s).
C. Provide and install one (1) additional access panel for each type over quantities shown on the drawings.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Package, handle, deliver and store at the job site in a manner that will avoid damage/rusting.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Any manufacturer who meets the requirements of the specification is acceptable.

2.02 ACCESS DOORS AND PANELS ASSEMBLIES

A. Wall/Ceiling-Mounted Panels for use in new drywall partitions and/or ceilings noted as AP #1 on drawings:
   1. Location: As indicated on drawings.
   2. Panel Material: Steel, hot-dipped zinc or zinc-aluminum-alloy coated.
   3. Size: 24 by 24 inches (609.6 by 609.6 mm).
   4. Door/Panel: Hinged, standard duty (14 gauge), with tool-operated spring and no handle.
   5. Frame: 16 gauge.
   6. Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.
   7. Finish: Gray powdered primer.
   8. Fire Rating: As required for panels in rated walls or ceilings. See Code Plan on Architectural Drawings for required rating.

2.03 WALL- AND CEILING-MOUNTED ACCESS UNITS

A. Manufacturers:
   1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
   2. Or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to proceeding with this work.

3.03 INSTALLATION

A. Install units in accordance with manufacturer's instructions.
B. Install frames plumb and level in openings, and secure units rigidly in place.
C. Position units to provide convenient access to concealed equipment when necessary.

END OF SECTION 08 31 00

SECTION 08 44 13
ALUMINUM STOREFRONT, ENTRANCES AND CURTAIN WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum glazed swinging doors.
B. Storefront noted as "SF-_(#)" on drawings.
C. Glazing.
D. Thermal Transmittance based on the following Energy Code:
   1. 2024 Minnesota Energy Code.
E. Joint sealants in contact with aluminum components.
F. Aluminum covers between curtain walls/storefront.
G. Firestopping between curtain wall/storefront and edge of floor slab.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details, glazing and infill.
C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and size and frequency of anchors for each opening based on the substrate materials.
   1. Shop drawings to be stamped by a registered professional engineer (PE) licensed in the State the project is located after a structural review to assure installation including but not limited to member sizes and anchorage meets the specified wind load.
      a. A manufacturer’s review to verify member sizes will be required prior to the Architect’s initial review of shop drawings. If after a P.E’s review, member sizes change after the Architect’s initial review, the Architect will be compensated for another Shop Drawing review.
D. Samples: Submit two samples 2 inch by 3 inch inches (50.8 by 76.2 mm) in size illustrating finished aluminum surfaces.
E. Test reports showing compliance with performance requirements.
F. Submit NFRC 100 report based on Gateway sizes that the aluminum systems, IGU spacer and glass meet the specified Climate Zone U values.
G. Installer's Qualification Statement (manufacturer's approval of installer).
H. Submit specimen warranty.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Design curtain wall/storefront and its structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the State in which the Project is located.
B. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of fabrication and installation experience and approved by manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.
B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.05 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.
B. Check actual unit opening by accurate field measurement before fabrication. Coordinate fabrication schedule with construction progress to avoid delay of work.

1.06 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Provide ten year manufacturer fabricated products warranty agreeing to repair or replace product(s) that fail in materials or factory workmanship.

C. Provide ten year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

D. Provide ten year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Curtainwall, Storefront and Entrance Doors:

1. EFCO Corporation: www.efcocorp.com.
2. Kawneer Company: www.kawneer.com.
3. Manko Window Systems, Inc: www.mankowindows.com.
4. Oldcastle Building Envelope: www.oldcastlebe.com.
5. Tubelite, Inc: www.tubeliteinc.com.
6. Wausau Window and Wall Systems: www.wausauwindow.com.
7. Storefront and Entrance Doors: Special-Lite : www.special-lite.com.

2.02 STOREFRONT

A. Exterior Storefront Frame Model (Noted as SF #___ on the drawings).

1. EFCO: 403X.
2. Kawneer: Trifab 451UT Framing System.
3. Manko: 2450xpt CG Series.
4. Oldcastle Building Envelope: 3000 XT Thermally Broken Storefront Framing.
5. Tubelite, Inc: TU24000 Therml=Block Series Framing.
6. Special-Lite: SL-450TB.

B. Interior Storefront Frame Model (Noted as SF#___ on the drawings).

1. EFCO: 402 (NT).
2. Kawneer: Trifab VersaGlaze 451 Framing System.
3. Manko: 1450 Series.
4. Oldcastle Building Envelope: FG 3000 Non-Thermal.
5. Tubelite, Inc: E14000 Series Framing.
6. Special-Lite: Flush Glazed System.

C. Frame profile: 4 ½ inch (114.3 mm) minimum depth x 2 inch (50.8 mm) minimum face with 12 inch (304.8 mm) sidelite base as detailed.

D. Frame reinforcing (hinge and latch): Continuous full height 1 x 1 ¼ x 3/16 inch (25.4 x 31.75 x 4.7625 mm) galvanized steel angle.

E. Dual Thermal barrier (exterior storefront): Poured in place, two part polyurethane structural barrier.

F. Provide adjustable sidelite base as detailed. Horizontals with brake material will not be permitted.

2.03 ENTRANCE DOORS

A. Door Model:

1. EFCO Series D518 Durastile – Wide Stile Entrance Door.
2. Kawneer 500 Heavy Wall Entrances.
3. Manko Window Systems: Heavy Wall Door Series 150H.
4. Oldcastle Building Envelope Rugged Door.
5. Wausau Window and Wall Systems: Monumental Door.
6. Tubelite, Inc: Monumental Entrance Series.

7. Door requirements:
    a. Stile: Width to accept panic hardware without overhanging stile. [Typically 5 inch (127 mm) minimum, without including glass stops].
    b. Minimum Door Material Thickness: 0.188 inch (4.7752 mm).
    c. Door Thickness: 2 inch (50.8 mm) minimum.
    d. Door (hinge stile): Continuous full height 1¼ x ¼ inch (31.75 x 6.35 mm) galv. steel bar stock.
    e. Bottom Door Rail: 12 inch (304.8 mm).
    f. Factory fabricated doors and factory glazed.
    g. Door manufacturer to supply subframes for Curtainwalls.
        1) EFCO: 5G92/5G93 with 9155 cover, thermal subframe with ¾ inch (19.05 mm) sightline.

2.04 PERFORMANCE REQUIREMENTS

A. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
    1. Provide capacity to withstand the following loads without deformation and without deflection greater than L/175 to spans up to 13'-6" (4114.8 mm) and L/240 + ¼ inch (6.25 mm) to spans greater than 13'-6" (4114.8 mm) with the following Wind Load Provision of ANSI/ASCE 7:
    2. Exposure Category = B.
    3. Occupancy Category = 1 with an Importance Factor of 0.87.
    4. Occupancy Category = 3 with a Basic Wind Speed of 125 mph (201.168 kph) and an Importance Factor of 1.15.
    5. Movement: Accommodate the following movement without damage to components or deterioration of seals:
        a. Expansion and contraction caused by 180 degrees F (82 degrees C) surface temperature.
        b. Expansion and contraction caused by cycling temperature range of 170 degrees F (77 degrees C) over a 12 hour period.
        c. Movement of curtain wall relative to perimeter framing.
        d. Deflection of structural support framing, under permanent and dynamic loads.
        e. Shortening of structural concrete columns.
B. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on indoor face when tested as follows:
    1. Test Pressure Differential: 15 psf (720 Pa).
    2. Test Method: ASTM E331.
C. Air Leakage (Fixed Windows/Storefront/Curtain wall: 0.06 cfm/sq ft (0.3 L/sec sq m) maximum leakage of wall area when tested in accordance with ASTM E283/E283M at 6.27 psf (300 Pa) pressure difference across assembly.
D. Thermal Performance Requirements:
    1. Condensation Resistance Factor "CRF" of Framing: 77, minimum, measured in accordance with AAMA 1503 for 5500 Series Curtain Wall framing based on an overall depth of 6".
    2. Thermal Transmittance: Provide framing systems which have an overall U-valve (Btu/hr. x sq.ft. x deg. F) at 15 mph exterior wind velocity of not more than values shown in the table below when tested in accordance with NFRC 100 with specified glazing.
        a. 2024 Minnesota Energy Code:
            1) Zone 6:
                (a) Fixed Curtain Wall and Storefront Overall U-value Including Glazing: 0.34 Btu/(hr sq ft deg F) (0.105506 W/(sq m K)), maximum.
                (b) Operable Curtain Wall Overall U-value Including Glazing: 0.42 Btu/(hr sq ft deg F) (0.126021 W/(sq m K)), maximum.
                (c) Entrance Door Overall U-value Including Glazing: 0.63 Btu/(hr sq ft deg F) (0.225665 W/(sq m K)), maximum.

E. Acoustical Performance Requirements:
   1. Sound Attenuation: STC of 30, minimum, from exterior to interior.
   2. Test Method: ASTM E90, with calculation in accordance with ASTM E413.

2.05 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
   1. Framing members for interior applications need not be thermally broken.
B. Glazing: See Section 08 80 00.
C. Column Covers: Aluminum, 11 gauge, 0.090 inch (2.286 mm) minimum thickness, full contact pressure bonded to rigid polyurethane insulation for flat surface, finish to match framing system.
D. Receptor heads: Extruded aluminum receptors to receive curtain wall or storefront, when thermal expansion or structural steel deflection requires them.

2.06 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).
B. Sheet Aluminum: ASTM B209/B209M.
C. Exposed Structural Steel Sections: ASTM A36/A36M; galvanized in accordance with requirements of ASTM A123/A123M.
D. Non-exposed Structural Steel Sections: ASTM A36/A36M; with cold-applied asphalt mastic, zinc chromate paint, or other nonconductive, nonabsorbent material.
E. Brackets and Reinforcements: High-strength aluminum where feasible; otherwise, nonmagnetic stainless steel or hot-dip galvanized steel complying with ASTM A 123.
F. Concrete/Masonry Inserts: Cast iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 123.
G. Dissimilar Metal Coating: Cold-applied asphalt mastic, zinc chromate paint, or other nonconductive, nonabsorbent material.
H. Fasteners: Aluminum, nonmagnetic stainless steel, or other noncorrosive type as required or recommended by curtain wall manufacturer.
   1. Do not use exposed fasteners except where unavoidable for application of hardware.
   2. Exposed fasteners: Match finish of members and hardware being fastened.
I. Exposed Sill Flashings: Aluminum sheet, 0.125 inch (3.175 mm) minimum thickness; finish to match framing members. Pre-bent, grind/ease and deburr all edges to elimunate sharp points prior to finishing.
J. Concealed Flashings: Stainless steel, 26 gauge, 0.0187 inch (0.48 mm) minimum thickness or extruded aluminum, 0.062 inch (1574.8 mm).
K. Firestopping: See Section 07 84 00.
L. Flexible Flashings: Grace Ice and Water Shield; www.gcpat.com or equal.
   1. 40 mil (1.016 mm) rubberized asphalt adhesive backed by high density cross laminated polyethylene.
   2. Tensile Strength: 250 psi (6.8948E +06 mpa) per ASTM D412 (Die C Modified).
   3. Elongation: 250% per ASTM D412 (Die C Modified).
M. Weatherseal Sealant: Silicone, with adhesion in compliance with ASTM C794; compatible with glazing accessories.
N. Sealant: Refer to Section 07 92 00 Joint Sealants.
O. Glazing Gaskets: Complying with ASTM C 864; Type as recommended by manufacturer to suit application to achieve weather, moisture, and air infiltration requirements.
P. Glazing and Glazing Accessories: See Section 08 80 00.
Q. Shop and Touch-Up Primer for Steel Components: Zinc oxide, alkyd, linseed oil primer appropriate for use over hand cleaned steel.
R. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.
S. Door Weatherstrip: Silicone treated plastic pile.

2.07 FINISHES

A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick.
   1. Dark Bronze.

2.08 FABRICATION

A. Any dimensions which may vary are indicated on drawings, with maximum and minimum dimensions required to achieve design requirements and coordination with other work. Field verify all opening dimensions.

B. Fabrication: To greatest extent possible, complete fabrication assembly, and finishing at manufacturers plant before shipment to project site. Disassemble components only as necessary for shipment and installation.
   1. Maintain accurate relation of planes and angles, with hairline fit of contacting members.
   2. Select members for fabrication so that adjacent anodized extruded aluminum members do not have color or texture variation greater than half the range indicated in the submitted samples.
   3. Factory-install all hardware except surface-mounted items.
   4. Perform fabrication operations, including cutting, fitting, forming, drilling, and grinding of metal work, in manner which prevents damage to exposed finish surfaces.

C. For hardware, perform these operations prior to application of finishes.

D. Welding: Comply with AWS recommendations to avoid discoloration; grind exposed welds smooth and restore mechanical finish.

E. Reinforcing: Install reinforcing as required for hardware and as necessary for performance requirements, sag resistance, and rigidity; separate dissimilar metals as specified under "Installation."

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other related work.

B. Verify that curtain wall openings and adjoining water-resistive and air barrier seal materials are ready to receive work of this section.

C. Verify that anchorage devices have been properly installed and located.

3.02 INSTALLATION

A. Install system in accordance with manufacturer's instructions.
   1. Storefront/curtainwall manufacturer’s or designated representative shall be present at installation of first unit of each system type to insure proper installation technique.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill and flexible flashings. Turn up ends and edges; seal to adjacent work to form water tight dam. File any remaining sharp points, being careful not to disturb the finish.

G. Install firestopping at each floor slab edge.

H. Pack exterior (mineral wool) insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

I. Separate aluminum exposed to weather from dissimilar metals; coat dissimilar metals that are in drainage cavities using one of the materials specified. Aluminum, stainless steel, zinc, cadmium, and small areas of white bronze are not considered dissimilar from each other.

J. Coat all metals that come into contact with masonry, concrete, and treated wood, using one of the materials specified.

K. Install joint sealers between framing and adjacent surfaces as indicated, to provide weathertight construction. Comply with requirements of Section 07 92 00 for installation of joint sealers.

L. Install glass as specified in Section 08 80 00 and according to the framing manufacturer's printed instructions.

M. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inch per 3 feet (1.5 mm/m) noncumulative or 0.5 inches per 100 feet (12 mm/30 m), whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/8 inch (9.525 mm) and minimum of 1/4 inch (6 mm).

3.04 FIELD QUALITY CONTROL

3.05 ADJUSTING

A. Adjust operating hardware to function properly without binding, and to close doors tightly. Ensure that weatherstrip makes contact with door surfaces.

3.06 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, take care to remove dirt from corners, and wipe surfaces clean.

C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

END OF SECTION 08 44 13

SECTION 08 51 13
ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Extruded aluminum windows with fixed sash noted as "W #" on the drawings.
B. Extruded aluminum windows with operating sash noted as "W #" on the drawings.
   1. Casement.
   2. Operating hardware.
   3. Insect screens.
C. Factory glazing.
D. Glazing.
E. Thermal Transmittance based on the following Energy Code:
   1. 2024 Minnesota Energy Code.
F. Joint sealants in contact with aluminum components.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Include component dimensions, internal drainage details, and descriptions of hardware and accessories.
C. Shop Drawings: Indicate opening dimensions, elevations of different types, framed opening tolerances, size, type and frequency of anchors for each opening based on the substrate materials, and installation requirements.
   1. Shop drawings to be stamped by a registered professional engineer (PE) licensed in the State the project is located after a structural review to assure installation including but not limited to member sizes and anchorage meets the specified wind load.
D. Samples: Submit two samples 2 inch by 3 inch inches (50.8 by 76.2 mm) in size illustrating finished aluminum surfaces.
E. Test Reports: Prior to submitting shop drawings or starting fabrication, submit test report(s) by independent testing agency showing compliance with performance requirements.
F. Installer's qualification statement (manufacturer's approval of installer).
G. Specimen warranty.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of installation experience and approved by manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of AAMA CW-10.
B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.05 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C).
B. Maintain this minimum temperature during and 24 hours after installation of sealants.
C. Check actual unit opening by accurate field measurement before fabrication. Coordinate fabrication schedule with construction progress to avoid delay of work.

1.06 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Manufacturer Warranty: Provide ten manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with manufacturer.
C. Manufacturer Warranty: Provide ten year manufacturer fabricated products warranty agreeing to repair or replace product(s) that fail in materials or factory workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Window Systems (.080 inch [2.032 mm] minimum wall thickness):
   1. EFCO Corporation; www.efcocorp.com.
   2. Kawneer; www.kawneer.com.
   3. Manko Window Systems; www.mankowindowsystems.com.
   4. Oldcastle Building Envelope; www.oldcastlebe.com.
   5. Wausau Window and Wall Systems: www.wausauwindow.com.

2.02 ALUMINUM WINDOWS

A. Aluminum Windows: Extruded aluminum frame and sash, factory fabricated, factory finished, with operating hardware, related flashings, and anchorage and attachment devices.
   1. Manufacturers/Products:
      a. EFCO Corporation: X Therm PX32.
      b. Kawneer: AA 4325 Ultra Thermal.
      c. Manko Window Systems: 3232 XPT Series.
      d. Oldcastle Building Products: Signature Series 3375.
      e. Wausua Window and Wall Systems: Invent 3250i-XLT.
   2. Operable Units: Double weatherstripped.
   3. Provide factory-glazed units, unless size limitations for shipping prohibit.
   4. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for operating hardware and imposed loads.
   5. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
   6. Movement: Accommodate movement between window and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.
   7. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
   8. Thermal Movement: Design to accommodate thermal movement caused by 180 degrees F (82.2 degrees C) surface temperature without buckling stress on glass, joint seal failure, damaging loads on structural elements, damaging loads on fasteners, reduction in performance or other detrimental effects.

B. Fixed.
   1. Minimum Performance Criteria: AC-AW80.

C. Operable.
   1. Minimum Performance Criteria: AC-AW80.

D. Casement Type:
   1. Construction: Thermally broken.
   2. Provide screens.
   3. Glazing: Single; clear; transparent.
   4. Exterior Finish: Class I natural anodized.
   5. Interior Finish: Class I natural anodized.

2.03 PERFORMANCE REQUIREMENTS

A. Grade: AAMA/WDMA/CSA 101/I.S.2/A440 having Performance Class of AW, and Performance Grade at least as high as specified design pressure.

B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
   1. Provide capacity to withstand the following loads without deformation and without deflection greater than L/175 to spans up to 13’-6” (4114.8 mm) and L/240 + ¼ inch (6.25 mm) to spans greater than 13’-6” (4114.8 mm) with the following Wind Load Provision of ANSI/ASCE 7:
   2. Exposure Category = B.

3. Occupancy Category = 3 with a Basic Wind Speed of 125 mph (201.168 kph) and an Importance Factor of 1.15.
4. Movement: Accommodate the following movement without damage to components or deterioration of seals:
    a. Expansion and contraction caused by 180 degrees F (82 degrees C) surface temperature.
    b. Expansion and contraction caused by cycling temperature range of 170 degrees F (77 degrees C) over a 12 hour period.
    c. Movement of windows relative to perimeter framing.
    d. Deflection of structural support framing, under permanent and dynamic loads.
    e. Shortening of structural concrete columns.

C. Thermal Transmittance: Provide framing systems which have an overall U-valve (Btu/hr. x sq.ft. x deg. F) at 15 mph exterior wind velocity of not more than values shown in the table below when tested in accordance with NFRC 100 with specified glazing.
1. 2024 Minnesota Energy Code:
    a. Zone 6:
        1) Fixed Units Overall U-value Including Glazing: 0.34 Btu/(hr sq ft deg F) (0.105506 W/(sq m K)), maximum.
        2) Operable Units Overall U-value Including Glazing: 0.42 Btu/(hr sq ft deg F) (0.126021 W/(sq m K)), maximum.
        3) Entrance Door Overall U-value Including Glazing: 0.63 Btu/(hr sq ft deg F) (0.225665 W/(sq m K)), maximum.

D. Water Leakage: No uncontrolled leakage on interior face when tested in accordance with ASTM E331 at differential pressure of 6.24 psf (298.7728 Pa).

E. Air Leakage:
1. Fixed Windows: 0.06 cfm/sq ft (0.028312 L/sec sq m) maximum leakage per unit area of outside window frame dimension when tested at 6.24 psf (298.7728 Pa)inward pressure difference in accordance with ASTM E283/E283M.
2. Operable Windows: 0.1 cfm/sq ft (0.5 L/sec sq m) maximum leakage per unit area of outside window frame dimension when tested at 6.24 psf (298.7728 Pa)inward pressure difference in accordance with ASTM E283/E283M.

F. Condensation Resistance Factor of Frame: 65, measured in accordance with AAMA 1503.

G. Acoustic Performance: Minimum outdoor-indoor transmission class (OITC) rating of 34, when tested in accordance with ASTM E90 and ASTM E1332.

2.04 COMPONENTS

A. Frames: 3-1/4 (Minimum Frame Depth) or 3-1/2 inch (82.55 or 88.9 mm)of 0.080 inch (2.032 mm) thick section; thermally broken with interior portion of frame insulated from exterior portion;, flush glass stops of snap-on type.

B. Glazing: See Section 08 80 00.

C. Sills: 0.125 inch (3.175 mm) thick, extruded aluminum; sloped for positive wash (pre-bent, grind/ease and deburr all edges to eliminate sharp points prior to finishing); fit under sash leg to 1/2 inch (12 mm) beyond wall face; one piece full width of opening over flexible flashing; with aluminum end dams..

D. Insect Screens: Extruded aluminum frame with mitered and reinforced corners; screen mesh taut and secure to frame; secured to window with adjustable hardware allowing screen removal without use of tools.
1. Screen Mesh: Stainless steel, window manufacturer's standard mesh.
2. Frame Finish: Same as frame and sash.

E. Receptor heads: Extruded aluminum receptors to receive window, when thermal expansion or structural steel deflection requires them.

F. Column Covers: Aluminum, 11 gauge, 0.090 inch (2.286 mm) minimum thickness, full contact pressure bonded to rigid polyurethane insulation for flat surface, finish to match framing system.

2.05 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.

B. Concealed Steel Items: Profiled to suit mullion sections; galvanized in accordance with ASTM A123/A123M.

C. Concealed Flashings: Stainless steel, 26 gauge, 0.0187 inch (0.48 mm) minimum thickness or extruded aluminum, 0.062 inch (1574.8 mm).

D. Flexible Flashings: Grace Ice and Water Shield; www.gcpat.com or equal.

1. 40 mil (1.016 mm) rubberized asphalt adhesive backed by high density cross laminated polyethylene.

E. Tensile Strength: 250 psi (6.8948E +06 mpa) per ASTM D412 (Die C Modified).

1. Elongation: 250% per ASTM D412 (Die C Modified).

F. Fasteners: Aluminum, nonmagnetic stainless steel, or other noncorrosive type as required or recommended by window manufacturer.

1. Do not use exposed fasteners except where unavoidable for application of hardware.
2. Exposed fasteners: Match finish of members and hardware being fastened.

G. Brackets and Reinforcements: High-strength aluminum where feasible; otherwise, nonmagnetic stainless steel or hot-dip galvanized steel complying with ASTM A 123.

H. Concrete/Masonry Inserts: Cast iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 123.

I. Dissimilar Metal Coating: Cold-applied asphalt mastic, zinc chromate paint, or other nonconductive, nonabsorbent material.

J. Glazing Gaskets: Complying with ASTM C 864; Type as recommended by manufacturer to suit application to achieve weather, moisture, and air infiltration requirements.

K. Sealant: Refer to Section 07 92 00 Joint Sealants.

L. Infill Panels: Insulated, aluminum sheet face and back, with edges formed to fit glazing channel and sealed.

1. Face Sheet: 0.125 inch (3.175 mm) thick.
2. Core: Rigid polyurethane insulation core with R-value of 13 (RSI-value of 2.29) and a Flame Spread Index of 25 or less and a Smoke Developed Index of 450 or less per ASTM E84.
3. Back Sheet: 0.032 inch (0.8128 mm) thick.
4. Finish: Match framing system.

2.06 HARDWARE

A. Operating hardware shall be 4-bar stainless steel arms for projected windows and 5 knuckle butt hinges with stainless steel pins for casement windows.

B. Sash lock: Lever handle with cam lock.

C. Operator: Lever action handle fitted to projecting sash arms with limit stops.

D. Window Opening Control Devices (WOCD): Provide operable window sash hardware that limits openings to only allow passage of 4 inch (102 mm) diameter rigid sphere or less, and are easily releasable to fully open without use of keys, tools, or special knowledge.

E. Pulls: Manufacturer's standard type.

2.07 FINISHES

A. Exterior: Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick or AAMA 611 AA-M12C22A44.

1. Dark Bronze.

2.08 FABRICATION

A. Any dimensions which may vary are indicated on drawings, with maximum and minimum dimensions required to achieve design requirements and coordination with other work. Field verify all opening dimensions.

B. Fabrication: To greatest extent possible, complete fabrication assembly, and finishing at manufacturers plant before shipment to project site. Disassemble components only as necessary for shipment and installation.

1. Maintain accurate relation of planes and angles, with hairline fit of contacting members.
2. Select members for fabrication so that adjacent anodized extruded aluminum members do not have color or texture variation greater than half the range indicated in the submitted samples.

3. Factory-install all hardware except surface-mounted items.
4. Perform fabrication operations, including cutting, fitting, forming, drilling, and grinding of metal work, in manner which prevents damage to exposed finish surfaces.
5. For hardware, perform these operations prior to application of finishes.

C. Welding: Comply with AWS recommendations to avoid discoloration; grind exposed welds smooth and restore mechanical finish.

D. Reinforcing: Install reinforcing as required for hardware and as necessary for performance requirements, sag resistance, and rigidity; separate dissimilar metals as specified under "Installation."

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that wall openings and adjoining water-resistive barrier materials are ready to receive aluminum windows; see Section 07 25 00.

B. Verify dimensions, tolerances, and method of attachment with other related work.

3.02 WINDOW INSTALLATION

A. Install windows in accordance with manufacturer's instructions.

B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.

C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.

D. Install sill and sill end dams over flexible flashing. File any remaining sharp points, being careful not to disturb the finish.

E. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

F. Install operating hardware not pre-installed by manufacturer.

3.03 TOLERANCES

A. Maximum Variation from Level or Plumb: 1/16 inches every 3 ft (1.5 mm/m) non-cumulative or 1/8 inches per 10 ft (3 mm/3 m), whichever is less.

3.04 FIELD QUALITY CONTROL

A. Provide services of aluminum window manufacturer's field representative to observe for proper installation of system and submit report.

3.05 ADJUSTING

A. Adjust hardware for smooth operation and secure weathertight closure.

3.06 CLEANING

A. Remove protective material from factory finished aluminum surfaces.

B. Wash surfaces by method recommended and acceptable to window manufacturer; rinse and wipe surfaces clean.

END OF SECTION 08 51 13

SECTION 08 63 00
METAL FRAMED SKYLIGHTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Engineering and drafting of production documents, including structural calculations of the entire skylight system.
B. Fabrication and erection of skylight frames.
C. Fabrication and erection of the aluminum gutter system including, when applicable, insulation and pitched liners.
D. Applied finish of aluminum extrusions and sheet.
E. Skylight glass and glazing.
F. Skylight related flashings.

1.02 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Extruded aluminum members with a system of alternate serrations for attachment of exterior glass retainers with 1/4-in. x 20 stainless steel screws and snap-on beauty caps.
   2. Condensation guttering system integral with skylight framing members for positive drainage of condensation.
   3. Flush glazed exterior horizontal joints with field applied structural silicone.
   4. Full silicone wet seals along both sides of all exterior glass retainers.

B. Performance Requirements:
   1. Structural Members: Of sufficient sizes to support design loads as prescribed by governing building codes.
   2. The deflection of the framing member in a direction normal to the plane of glass when subjected to a uniform load deflection test in accordance with ASTM E330, and per the above specified loads, shall not exceed L/175, up to 1-in. maximum, for clear spans under 20-ft., or L/240 for clear spans greater than 20-ft.
   3. The deflection of a framing member in a direction parallel to the plane of glass, when carrying its full dead load, shall not exceed an amount which will reduce the glass or panel bite below 75% of the design dimension and the member shall have a 1/8-in. minimum clearance between itself and the edge of the fixed panel, glass, or component immediately adjacent, nor shall it impair the function of or damage any joint seals.
   4. Water Penetration: No water penetration shall occur when the system is tested in accordance with ASTM E331 using a differential static pressure of (20% of the inward acting design wind load pressure, but not less than (12 psf). Water penetration is defined as the appearance of uncontrolled water other than condensation on the interior surface of any part of the skylight.
      a. Drain water penetrating at joints, as well as condensation occurring within the system to exterior face of the work.
   5. Thermal Movement: Provide for expansion and contraction of component materials as will be caused by an exterior surface temperature range of (+/-) 85 ºF, ranging from –20 ºF to 150 ºF, and an interior surface temperature range of (+/-) 40 ºF, ranging from 40 ºF to 120 ºF. Adjustments in the exterior and interior temperature ranges should be made, based on specific project locations and conditions. The skylight system should allow for thermal movements without buckling, sealant failure, undue material stress, and other detrimental affects.
   6. Where permitted by code, a 1/3 increase in allowable stress for wind or seismic load shall be acceptable, but not in combination with any reduction applied to combined loads. In no case shall allowable values exceed the yield stress.
   7. Compression flanges of flexural members may be assumed to receive effective lateral bracing only from anchors to the building structure and horizontal glazing bars or interior trim which are in contact with 50% of the member's total depth.

8. Skylight framing is designed to be self-supporting between the support construction. The skylight(s) will impose reactions to the support construction. All adjacent and support construction must support the transfer of all loads including horizontal and vertical, exerted by the skylight(s). Design or structural engineering services for the supporting structure or building components not included in the skylight scope are not included under this section.

1.03 SUBMITTALS

A. Submit shop drawings showing plans, elevations and sections as required to fully describe the skylight construction for the Architect's approval prior to starting fabrication.

B. Submit structural calculations prepared in accordance with the Aluminum Association's Specifications for Aluminum Structures (SAS30) by a structural engineer qualified in the design of self-supporting sloped glazed systems licensed in Minnesota.

C. With regard to structural silicone joinery, submit:

1. Certification that adhesion of sealant to samples of metal and glass is adequate when tested in accordance with ASTM C794.
2. Certification that materials in contact with sealant are compatible with sealant after being exposed o 2,000-4,000 micro watt ultra-violet radiation for twenty-one (21) days.
3. Statement that stress on each detailed sealant joint will not exceed design stress of sealant when exposed to specified wind loads.

D. Submit one (1) 12-in. x 12-in. sample of each type of glass.

E. Submit digital as-built drawings and cleaning and maintenance manuals upon completion of skylight installation.

F. Certification that insulating glass units will withstand specified design loads.

1.04 QUALITY ASSURANCE

A. Work of this Section, including design, engineering, fabrication, finishing, preparation at the job site, erection and glazing of the skylight system shall be the responsibility of the skylight manufacturer. The manufacturer shall be regularly engaged in the preceding phases of construction of skylights and able to demonstrate that they have performed successfully on comparably sized projects and of comparable design complexity over at least the previous ten (10) years.

1.05 WARRANTY

A. Submit manufacturer's warranty certifying that skylight work was furnished and installed in accordance with the Contract Documents.

B. Certify that skylight frame is free of defects in design, material, and construction for a period of ten (10) years from the Date of Substantial Completion.

C. Warrant glass against defective materials, delamination, seal failure, and defects in manufacture per the glass manufacturer's standard warranties from date of manufacture.

D. Warrant structural sealant for a period of ten (10) years per sealant manufacturer's standard warranty of merchantable quality. Warranty shall certify that cured sealant:

1. Will not become brittle or crack due to weathering or normal expansion and contraction of adjacent surfaces.
2. Will not harden beyond a Shore A durometer of 50, nor soften below a minimum of 10 points.
3. Will not change color significantly when used with compatible back-up materials.
4. Will not bleed significantly.

E. Warrant finish per the manufacturer’s standard warranties from date of application.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Super Sky Products Enterprises, LLC;
10301 North Enterprise Drive, Mequon, Wisconsin 53092; Phone (800) 558-0457, (262) 242-2000;
Fax (262) 242-7409; www.supersky.com.

2.02 MATERIALS

A. Framework:
   1. Principal Supporting Members: .125-in. minimum thickness extruded aluminum, alloy 6005-T5 or 6061-T6 per ASTM B221. Sizes, shapes and profiles as per Super Sky Products' standard components.
   2. Snap-on Covers and Miscellaneous Non-supporting Trim: .062-in. minimum thickness extruded aluminum, alloy 6063-T5 per ASTM B221.
   3. Supporting aluminum gutters: thickness as prescribed by skylight engineer, based on skylight reactions and applied design loads.
   4. Principal Formed Metal Members: .125-in. minimum thickness aluminum, alloy 5052 per ASTM B209.

B. Glazing Strips:
   1. Extruded EDPM rubber designed to comply with the following specifications:
      a. Hardness: ASTM D2240, Type A: Durometer 50 (+/-5).
      b. Tensile Strength: ASTM D412. 800 psi (5515.81 kPa).
      c. Elongation: 300% (min.).
      d. Color: Black.
   2. Compression Set: ASTM D395 Method B, 22 hours @ 212 ºF: 25% (max.).
   3. Heat Aging Characteristics:
      a. 70 hours @ 212 ºF.
      b. Hardness: ASTM D2240, Type A: Durometer 50 (+/-5).
      c. Tensile Change: ASTM D412. -10%.
      d. . Elongation Change: ASTM D412: -20%.
   4. ASTM D1171 Weather Resistance at 1 Part Ozone per Million, 500 hours at 20% Elongation: No cracks.
   5. No visual checks, cracks or breaks after completion of tests.

C. Setting Blocks:
   1. Extruded Type II silicone rubber designed to permit adhesion and comply with the following specifications:
      a. Hardness: ASTM D2240, Type A: Durometer 80 (+/-5).
      b. Color: Black.

D. Fasteners:
   1. For Exterior Cap Retainers: ASTM A193 B8 300 series stainless steel screws.
   2. For Framework Connections: ASTM B211 2024-T4 aluminum, ASTM A193 B8 300 series stainless steel, and ASTM B316 aluminum rivets, as required by connection.
   3. For Anchoring Skylight to Support Structure: ASTM A307 zinc plated steel fasteners.
   4. Exposed stainless steel truss head mechanical fasteners are utilized in accordance with standard connection details.

E. Flashing:
   1. 5005 H34 Aluminum040-in. minimum thickness.
   2. Sheet metal flashings/closures/claddings are to be furnished shop formed to profile in min. 10-ft. lengths. When lengths exceed 10-ft., field trimming of the flashing and field forming the ends is necessary to suit as-built conditions. Sheet metal ends are to overlap 6-in. to 8-in. minimum, set in a full bed of sealant and riveted if required.

F. Exposed metal finish interior and exterior to comply with the following:
   1. Anodized Coatings:
      a. AAMA 611-98 Architectural Class I electrolytically deposited color anodized Type AA-M10C22A44: dark bronze.

G. Glass:
   1. Standard Certification Requirements:
      a. Heat Treated Glass: ASTM C1048, with surface stress of 5,000 (+/-) 1500 psi (10342.14 kPa).
      b. Laminated Glass: Two lites interleaved with polyvinyl butyral (PVB). Units must meet criteria of ANSI Z97.1- 1984 and CPSC 16 CFR 1201 for safety glazing. Provide PVB layer of 0.030-in. for all glass units unless a coating, and/or frit is applied to the inside face of the laminate thereby necessitating a 0.060-in. PVB layer.
      c. Insulating Glass: CBA rated by the Insulating Glass Certification Council (IGCC) when tested in accordance with ASTM E773 and ASTM E774. Dual edge seals with the secondary seal being silicone. Exterior lite of fully tempered glass and interior lite of laminated glass.
   2. Performance Requirements:
      a. Probability of breakage not to exceed 8/1000 for vertical glass and 1/1000 for sloped glass upon first application of design wind and live load pressures. For glass selection, design wind pressure for a one minute duration. For loads of longer duration use standard engineering practices for glass selection.
      b. Probability of breakage due to anticipated thermal stress not to exceed 8/1000 for vertical glass and 1/1000 for sloped glass.
   3. Glazing Unit Composition:
      a. Sloped glass units are to be 1-5/16”.
      b. Vertical glass units are to be 1”.
      c. Bronze tint with solarban 60 low-e

H. Sealants:
   1. Structural Flush Glazed Joints: High performance silicone sealant applied in accordance with manufacturer's recommendations.
   2. Non-structural Flush Glazed Joints and Weather Seal Joints: Silicone sealants applied in accordance with manufacturer's recommendations.
   3. 3. Structural silicone sealant properties after 21 days at 77 degrees Fahrenheit (25 degrees Celsius) and 50% relative humidity:
      a. a. Hardness: ASTM D2240 Shore A, 35 durometer.
      b. Ultimate Tensile Strength: ASTM C1135: 25% extension – 45psi; 50% extension 60psi
      c. Staining: ASTM C1248; None on concrete, marble, granite, limestone, and brick.
      d. Joint Movement Capability after 14 Day Cure: ASTM C719, (+/-) 50%.
      e. Peel Strength (aluminum, glass, concrete): ASTM C794, 32 ppi.
      f. Service temperature range: -30 degrees Fahrenheit (-1.11 degrees Celsius) to 300 degrees Fahrenheit (148.89 degrees Celsius).
      g. Weathering after 10,000 hours: ASTM C1135 using QUV Weatherometer: 25% extension – 35psi; 50% extension – 50psi.
   4. Structural silicone shall not be used to support dead weight of vertical glass or panels.

2.03 FABRICATION

A. Construct skylight(s) using extruded aluminum members.
B. Construct skylight(s) using a continuous aluminum curb with expansion joints as required.
C. Insofar as practicable, fit and assemble work in the manufacturer's shop. Work which cannot be permanently assembled shall be shop-assembled, marked, and disassembled before shipment to the jobsite.
D. Design rafter bars for slide-in type spline glazing strips.
E. Design glass retainer fasteners to resist uplift loadings. Spacing to be determined by structural calculations, when applicable.
F. Use snap-on beauty caps to conceal glass retainers and glass retainer fasteners.
G. Shop locate drill and bolt, or weld aluminum clips to framing members.
H. Set glass with interior and exterior EDPM glazing strips.

I. Use silicone setting blocks to support glass and to provide edge clearances and glass bites as outlined below, in accordance with FGMA recommendations:
   1. Set blocks not less than 6-in. from edge of glass for support unit.
   2. Glass Bite: Not less than 1/2-in. nor more than 5/8-in. on any side of glass unit.
   3. Maintain 1/4-in. edge clearance between glass and adjacent metal framework.
   4. Use rubber spacers to maintain separation of glass and adjacent metal framework.

J. Locate weepholes in curb to positively drain condensation to exterior of skylight at each rafter connection.

PART 3 EXECUTION

3.01 EXAMINATION

A. Upon arrival to the jobsite for installation of the specified work, the manufacturer's erector is to examine the structure and substrate to determine that they are properly prepared, dimensionally accurate, and ready to receive the skylight work included herein. Report any discrepancies to the General Contractor. Correction of faulty work to be at the expense of the responsible party/s. The skylight manufacturer is not responsible for faulty structure or substrate.

3.02 PREPARATION

A. Contact between aluminum and dissimilar metals shall receive a protective coating of asphaltic paint for the prevention of electrolytic action and corrosion.

B. Skylight manufacturer and manufacturer's erector excludes all field measuring, demolition, removal, replacement, or re-work of any existing material.

3.03 INSTALLATION

A. Install skylight frame, glass and accessory items as needed in accordance with manufacturer's instructions.

B. Install skylight system under the direction of the skylight manufacturer's designated erector.

C. Erect system plumb and true, in proper alignment and relation to established lines and grades as shown on approved shop drawings.

D. Anchor skylight to structure in strict accordance with approved shop drawings.

E. Use high performance silicone sealants to seal horizontal joints between glass panels and silicone sealant to wet seal joints between snap-on cap retainers and glass.

F. Apply sealing materials in strict accordance with sealant manufacturer's instructions. Before application, remove mortar dirt, dust, moisture and other foreign matter from surfaces it will contact. Mask adjoining surfaces to maintain a clean and neat appearance. Tool sealing compounds to fill the joint and provide a smooth finish.

G. Furnishing of temporary covering and weather-proofing of the skylight openings, if required by the General Contractor, and removal of the protective measures during and after the skylight installation is excluded by the manufacturer and the manufacturer's erector. ANY TEMPORARY COVERINGS THAT MAY BE REQUIRED ARE NOT TO OBSTRUCT OR INTERFERE WITH THE SKYLIGHT INSTALLATION IN ANYWAY.

3.04 TOLERANCES

A. All parts of the work, when completed, shall be within the following tolerances:
   1. Maximum variation from plane or location shown on approved shop drawings: 1/8-in. per 12-ft. length, or 1/2-in. in total length.
   2. Maximum offset from true alignment between two members abutting end-to-end, edge-to-edge in line or separated by less than 3-in.:1/32-in.

3.05 FIELD QUALITY CONTROL

A. Water Leakage: Field check in accordance with AAMA 501.2 in proportionate areas. There shall be no uncontrolled water leakage as defined in AAMA 501.2. Water supply to the skylights, with adequate water pressure, is to be furnished by the General Contractor. Tests are to be conducted upon completion of the installation with no remobilization or down time included to accommodate either water supply availability or witness personnel schedules. Testing is to be performed by the manufacturer's authorized personnel with a maximum of five (5) man-hours for set-up, testing and clean-up. Independent laboratory testing and reports, if required, are to be ordered and directed by the Owner and/or General Contractor.

3.06 CLEANING

A. Install skylight frame and associated metal to avoid soiling or smudging the finish.

B. Clean glass and frame at time of installation. Final cleaning, if required, subsequent to completion of project, is not to be performed by the manufacturer.

3.07 PROTECTION

A. The skylight manufacturer does not provide, nor does it include any temporary protection of the skylight and its materials after the installation is complete. Protection of the skylight from ongoing work by other trades shall be the responsibility of the General Contractor. The manufacturer is responsible only for the damage caused by the personnel under its control and responsibility.

END OF SECTION 08 63 00

SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Interior Glazing
      a. Safety glass in locations identified in Part 3.
      b. Clear glass in HM doors and frames.
      c. Clear glass in wood doors.
      d. Laminated translucent glazing.
      e. Laminated glass in doors and frames.
   2. Exterior Insulated Glazing
      a. Safety glass in locations identified in Part 3.
      b. Clear glass in aluminum doors.
      c. Clear glass in windows, storefront and curtainwall.

1.02 QUALITY ASSURANCE

A. Reference Specification: Glazing Manual by Flat Glass Marketing Association.
B. Materials: Conform in all respects to the "Safety Standard for Architectural Glazing Materials" (16CFR 1201) issued by the Consumer Product Safety Commission and Chapter 24 of the International Building Code.
C. Insulating glass units to be CBA rated with the Insulating Glass Certification Council (IGCC) in accordance with ASTM Specifications E-773 and E-774.

1.03 SUBMITTALS

A. Submit per Section 01 30 00 - Administrative Requirements.
   1. Product data:
      a. Insulating glass units.
   2. Samples for each type glass specified.
   3. Sample warranties.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Package, handle, deliver and store at the job site in a manner that will avoid damage.
B. Reject scratched glass.

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Manufacturer Warranty: Provide five-year manufacturer warranty against failure of laminated glass products. Complete forms in Owner's name and register with manufacturer.
C. Manufacturer Warranty: Provide ten manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS/FABRICATORS

A. Glass Manufacturers and/or Coating Manufacturers:
   1. AGC Glass North America, Inc.: www.us.agc.com.
   2. Cardinal Glass Industries: www.cardinalcorp.com.
   3. Guardian Industries, LLC: www.sunguardglass.com.
   4. Old Castle Building Products: www.oldcastlebe.com.
   5. Pilkington North America, Inc.: www.pilkington.com.
   6. Viracon, Inc.: www.viracon.com.
   7. Vitro Architectural Glass: www.vitroglazings.com.

B. Fire Rated Glass Manufacturers:
   1. SAFTI First, www.safti.com.
   2. Technical Glass Products, www.fireglass.com.
   3. Vetrotech Saint-Gobain, www.vetrotechusa.com.
   4. McGrory Glass, www.mcgrory.com.

2.02 INTERIOR GLAZING

A. Clear:
   1. Clear Float Glass, ¼ inch (6.35 mm) thick.
   2. Clear Float Glass, 1/2 inch (12.7 mm) thick [for panes 72 inches (1828.8 and higher].

B. Safety:
   1. Clear heat-tempered float glass, ¼ inch (6.35 mm) thick.
   2. Clear Float Glass, 1/2 inch (12.7 mm) thick [for panes 72 inches (1828.8 and higher].

C. Fire Rated:
   1. Non-wire glass products with a fire rating to match opening schedule on the drawings by one of the following are acceptable:
      a. McGrory Glass
      b. SAFTI First.
      c. Technical Glass Products.
      d. Vetrotech Saint-Gobain.

2.03 EXTERIOR GLAZING

A. Low-E glass to be solar control (MSVD coating process).

B. For fire rated glazing, substitute appropriate lites with Fire Rated Glazing as specified under interior glazing.

C. For locations requiring safety glazing, provide heat-tempered glass for inboard and outboard lites, unless laminated glazing is called out on drawings or specified.

D. Clear Insulated Glass: (Type EC1).
   1. 1 inch (25.4 mm) overall thickness insulated glass.
      a. Exterior glass ply/coating:
         1) ¼ inch (6.35 mm) clear with:
            (a) Vitro Solarban 60.
            (b) Guardian SN68.
            (c) AGC Energy Select 40.
            (d) Similar products by other specified glass/coating manufacturers.
         2) Low-E on Surface #2.
      b. Spacer: Warm edge.
      c. Airspace: ½ inch (12.7 mm) argon filled.
      d. Silicone: Black.
      e. Interior glass ply: ¼ inch (6.35 mm) clear.
   2. Performance Requirements:
      a. Transmittance:
         1) Visible light: 70%.
      b. Reflectance:
         1) Visible Light Exterior: 11%.
         2) Visible Light Interior: 12%.
      c. ASHRAE U-Value:
         1) Winter Nighttime: 0.24 BTU.
      d. Solar Heat Gain Factor (SHGC): 0.39
      e. LSG: 1.79.
   3. For units requiring “Safety Glazing” per Part 3 of Specification, provide “safety” glass plys. Specified under interior glazing.

2.04 ACCESSORIES

A. Glazing Sealant: Two-part silicone similar to Dow Corning 982 Insulating Glass Sealant. Glazer is responsible to verify compatibility to primary seal material.

B. Setting Blocks: 100% silicone, 85+/- 5 Shore "A" durometer, located and sized to accommodate the requirements of the glazing fabricator, and compatible with glazing sealant.

C. Spacers: Warm edge thermal plastic.

D. Primer - Sealers, Cleaners: As recommended by glass manufacturer.

E. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.

PART 3 EXECUTION

3.01 INSPECTION

A. Check that glazing channels are free of burrs, irregularities, and debris.

B. Check that glass is free of edge damage or face imperfections.

C. Do not proceed with installation until conditions are satisfactory.

3.02 PREPARATION

A. Field Measurements:

1. Measure size of frame to receive glass.
2. Compute actual glass size, allowing for edge clearances.

B. Preparation of Surfaces:

1. Remove protective coatings from surfaces to be glazed.
2. Clean glass and glazing surfaces, to remove dust, oil and contaminants. Wipe dry.

3.03 SAFETY GLAZING

A. Install safety glazing at the following locations and/or as required by local building codes.

1. Doors and adjacent glazing:
   a. In doors when glass is wider than 2-15/16 inch (74.6125 mm) .
   b. Glass within 24 inch (609.6 mm) of vertical door edges and to a point 60 inch (1524 mm) above the floor.
2. Individual fixed or operable panels when any of the following conditions are met:
   a. Individual panes 9 square feet (0.836127 square meter) and greater.
   b. Glass within 18 inch (457.2 mm) of the floor.
   c. When exposed individual pane is greater than 36 inch (914.4 mm) above the floor, except when a horizontal mullion is detailed between 34 inch (863.6 mm) and 38 inch (965.2 mm) above the floor.
   d. Walking surfaces within 36 inches (914.4 mm) horizontally of the pane of glazing.
3. Stairs, landings and ramps:
   a. In guards or railings adjacent to stairs, landings and ramps.
   b. Glazing adjacent to stairways, landings and ramps within 36 inch (914.4 mm) horizontally of walking surface and less than 60 inch (1524 mm) above pane of adjacent walking surface.
   c. Glazing adjacent to bottom tread of stairways within 60 inch (1524 mm) horizontally and less than 60 inch (1524 mm) above the nose of the tread, unless the glass is protected by a guardrail and the glass is greater than 18 inch (457.2 mm) of the guardrail.

3.04 INSTALLATION

A. Install glass in accordance with glass manufacturer's current printed instructions.

B. Install sliding glass doors in accordance with manufacturer's instructions and as shown on Drawings.

3.05 CLEANING

A. Remove excess glazing compound from installed glass.

B. Remove labels from glass surface as soon as installed.

C. Wash and polish both faces of glass.

D. Remove debris from work site.

3.06 PROTECTION OF COMPLETED WORK

A. Attach crossed streamers away from glass face.

B. Do not apply markers to glass surface.

C. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 08 80 00

SECTION 08 91 00
LOUVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pre-finished aluminum exterior wall louvers, frames and accessories.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials, including material thicknesses and finishes.

C. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, and tolerances; head, jamb and sill details; blade configuration, screens, blank-off areas required, and frames.

D. Samples: Submit two samples 2 by 2 inches (50 by 50 mm) in size illustrating finish and color of exterior and interior surfaces.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.03 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer's warranty against distortion, metal degradation, and connection failures of louver components.

1. Finish: Include twenty year coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Louvers:

1. Products specified are by Ruskin: www.ruskin.com.
2. Equivalent products by other manufacturers are acceptable.

2.02 LOUVERS

A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified in accordance with AMCA 511.

1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf (of 1.2 kPa) without damage or permanent deformation.
2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft (3.1 g/sq m) water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
4. Screens: Provide bird screens at intake and exhaust louvers.

B. Stationary Louvers: Model ELF 445DX; Horizontal blade, extruded aluminum construction, with concealed intermediate mullions, up to 120 inches (3,048 mm).

1. Free Area: 50 percent, minimum.
2. Blades: Drainable.
3. Frame: 4 inches deep (100 mm deep), channel profile; corner joints mitered and , with continuous recessed caulking channel each side.
4. Aluminum Thickness: Frame 12 gauge, 0.0808 inch (2.05 mm) minimum; blades 12 gauge, 0.0808 inch (2.05 mm) minimum.
5. Aluminum Finish:
    a. Class I Color Anodized: Color as selected from manufacturers standard line.

2.03 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063-T6 or 6063-T5.

2.04 FINISHES

A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick.

2.05 ACCESSORIES

A. Bird Screen: Interwoven wire mesh of steel, 14 gauge, 0.0641 inch (1.63 mm) diameter wire, 1/2 inch (13 mm) open weave, diagonal design.

B. Fasteners and Anchors: Galvanized steel.

C. Flashings and Sill Flashing: Of same material as louver frame, formed to required shape, single length in one piece per location.

D. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared openings and flashings are ready to receive this work and opening dimensions are as indicated on shop drawings.

B. Verify that field measurements are as indicated.

3.02 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions.

B. Install louvers level and plumb.

C. Set sill members and sill flashing in continuous bead of sealant.

D. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.

E. Secure louver frames in openings with concealed fasteners.

F. Coordinate with installation of mechanical ductwork.

3.03 CLEANING

A. Strip protective finish coverings.

B. Clean surfaces and components.

END OF SECTION 08 91 00

SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
   1. Resilient tile and sheet.
   2. Carpet tile.
   3. Thin-set ceramic tile and stone tile.
   4. Grinding or leveling of floors if required to meet floor flatness requirements.
   5. Including the following Specification Sections:
      a. 09 30 00 Tile.
      b. 09 65 00 Resilient Flooring.
      c. 09 68 13 Carpet Flooring.

B. Removal of existing floor coverings.

C. Preparation of new and existing concrete floor slabs for installation of floor coverings.

D. Testing of concrete floor slabs for moisture and alkalinity (pH).

E. Testing of existing concrete floor slabs for moisture and alkalinity (pH) has already been conducted; test report is attached.

F. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
   1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.

G. Patching compound.

H. Epoxy Moisture Mitigation System over existing slab on grade, unless a breathable flooring is being installed.

I. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens); 2021.

J. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete; 2020.

K. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.

L. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.

M. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; 2018.

1.02 SUBMITTALS

A. Submittals are referenced in the Flooring Specifications.

B. Visual Observation Report: For existing floor coverings to be removed.

C. Product Data: Substrate preparation materials.

D. Epoxy Moisture Mitigation System Product Data: Manufacturer's published data on each product to be used for remediation.
   1. Manufacturer's qualification statement for training of Installer.
   2. Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.

1.03 QUALITY ASSURANCE

A. Epoxy Moisture Mitigation Coating Installer Qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer, and able to provide at least 3 project references showing at least 3 years' experience installing moisture emission coatings.

1.04 CONCRETE MOISTURE AND ADHESION

A. For new concrete slabs on grade, this project is utilizing a Moisture Vapor Reduction Admixture (MVRA) as specified in Section 03 30 13.
   1. The MVRA manufacturer will perform all moisture testing of new slabs on grade. No further field slab moisture or pH testing shall be required by the flooring installer. Probe type moisture tests will not provide accurate results with concrete that has MVRA admixture, as the moisture remains irremovable and suspended within the slab.
   2. The flooring installer is to perform a field bond test with the specified flooring products and the flooring manufacturer's recommended adhesive for non-porous substrates, with the MVRA manufacturer's representative present. The bond test shall be performed to adhesive manufacturer's guidelines and ASTM F710.
   3. At completion of testing and prior to the installation of any flooring, the MVRA manufacturer will issue the following warranties/guarantees:
   4. Life of Concrete Warranty that states the MVRA products ability to stop moisture vapor emission from the concrete itself for the life of the concrete.
      a. Up to 25 pounds of moisture per ASTM F1869 or 100% RH per ASTM F2170.
      b. Adhesion Guarantee stating the MVRA manufacturer will guarantee and warrant that the materials bond tested will adequately bond directly to the MVRA dosed concrete.

1.05 FLOOR FLATNESS

A. For new concrete slabs on grade and elevated structural slabs/topping as specified in Section 03 30 13 floor flatness is specified per ACI 117 as follows:
   1. For floors requiring a "moderately flat tolerance" (typically carpet):
      a. F (F) Flat tolerance with an overall value of 25 and a minimum localized value of 15.
      b. F (L) Flat tolerance with an overall value of 20 and a minimum localized value of 12.
      c. Measured by a manual straightedge method a "flat" floor surface classification, maximum gap for 90% compliance, samples not to exceed 3/8 inch (9.53 mm) and for 100% compliance, samples not to exceed 5/8 inch (15.88 mm).
   2. For floors requiring a "flat or greater tolerance" [typically resilient, vinyl tile, and thin-set ceramic/porcelain tile up to 16 inches (406 mm) in size without mortar beds and finishes with greater tolerances of resilient athletic flooring and thin-set ceramic/porcelain tile over 16 inches (406 mm) in size without mortar beds]:
      a. F (F) Flat tolerance with an overall value of 35 and a minimum localized value of 21.
      b. F (L) Flat tolerance with an overall value of 25 and a minimum localized value of 15.
      c. Measured by a manual straightedge method a "flat" floor surface classification, maximum gap for 90% compliance, samples not to exceed ¼ inch (6.35 mm) and for 100% compliance, samples not to exceed 3/8 inch (9.53 mm).

B. The flooring contractor will be responsible to provide the necessary means (i.e., grinding/leveling) for additional leveling as required by the flooring manufacturer.

C. The flooring contractor will be responsible to provide the necessary means (i.e., grinding/leveling) for leveling as required by the flooring manufacturer for existing concrete floor substrates as follows:
   1. On remodeling projects, assume 33% of area will require filling, or leveling up to 1/4 inch (6.35 mm) in height.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect products in accordance with manufacturer's instructions and recommendations.

B. Deliver materials in manufacturer's packaging; include installation instructions.

C. Keep materials from freezing.

1.07 WARRANTY

A. Moisture Control system need to reduce moisture emissions coming from concrete slab to a rate slow enough that the flooring system – adhesive and floor covering will not be affected.
   1. 20-year manufacturer material and labor warranty.

PART 2 PRODUCTS

2.01 MATERIALS

A. Substrate Prep and Patching:
   1. Patching Compound/Subfloor Filler:
      a. Self-drying cementitious moisture-, mildew-, and alkali-resistant compound, capable of being feathered to nothing at edges.
      b. Compressive Strength: 3000 psi, (210.92 kg/cm2), after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.
      c. Thickness: Up to 1/2 inch (12.7 mm).
      d. VOC: 0 g/L.
      e. Products:
         1) ARDEX Engineered Cements; ARDEX Feather Finish: www.ardexamericas.com.
         2) Equivalent products by other manufacturers are acceptable.
   2. Crack and Joint Treatment:
      a. Dormant Cracks and Sawcuts: Two part, low viscosity, rigid polyurethane.
         1) Tensile Strength: 4,150 psi (28.6 N/sq.mm), minimum, after 28 days, when tested in accordance with ASTM 638.
         2) Elongation: 6% when tested in accordance with ASTM 638.
         3) Die C Tear: 243 pli (425.5 N/cm) when tested in accordance with ASTM 624.
         4) VOC: 0 g/L.
         5) Thickness: No limits.
         6) Products:
            (a) ARDEX Engineered Cements; ARDEX Ardifix: www.ardexamericas.com.
            (b) Equivalent products by other manufacturers are acceptable.
      b. Moving Joints and Cracks: Two part, self leveling, semi-rigid polyurea fast setting joint sealant.
         1) Tensile Strength: Approx. 1,200 psi (0.08 N/sq. m), when tested in accordance with ASTM D412.
         2) Elongation: 82% when tested in accordance with ASTM D412.
         3) Bond Strength: 400 psi (2.76 N/sq. m), when tested in accordance with ASTM C882.
         4) VOC: 8 g/L.
         5) Thickness: 1/4 to 2 inches (6.35 to 50.8 mm).
         6) Products:
            (a) ARDEX Engineered Cements; ARDEX Ardiseal Rapid Plus: www.ardexamericas.com.
            (b) Equivalent products by other manufacturers are acceptable.
   3. Substrate Prep: Rapid drying moisture resistant patch of portland and other hydraulic cements, trowel grade underlayment.
      a. Moisture Tolerance: 100% RH.
      b. VOC: 0 g/L.
      c. Products:
         1) ARDEX Engineered Cements; ARDEX MRF: www.ardexamericas.com.
         2) Equivalent products by other manufacturers are acceptable.
   4. Self Leveling Topping/Underlayment: Polymer blended portland cement based, self leveling topping.
      a. Primer as recommended by manufacturer.
      b. Compressive Strength: 5000 psi (351.53kg/cm2) after 28 days, when tested in accordance with ASTM C109/C109M.

c. Flexural Strength: 1,200 psi (84 kg/cm2) at 28 days, when tested in accordance with ASTM C348.
d. VOC: 0 g/L.
e. Thickness: 1/8 to 1-1/2 inch (3.175-38.1 mm).
f. Products:
1) ARDEX Engineered Cements; ARDEX K15: www.ardexamericas.com.
2) Equivalent products by other manufacturers are acceptable.

B. Epoxy Moisture Mitigation System: 100% solids, single coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
1. Epoxy Moisture Control System:
a. Permeability: <0.10 perms, when tested in accordance with ASTM E96.
b. RH Readings: Up to 100%.
c. 14 pH solution: No effect, when tested in accordance with ASTM D1308.
d. VOC: 19.9 g/L, A+B, when tested in accordance with ASTM D2369.
e. Thickness: As required for application and in accordance with manufacturer's installation instructions.
f. Crack Repair: Products as recommended by manufacturer.
g. Products:
1) ARDEX Engineered Cements; ARDEX MC RAPID: www.ardexamericas.com.
2) HPS North America/Schonox; EPA Rapid: www.hpsubfloors.com
2. Hydraulic Cement-based self leveling topping:
a. Primer as recommended by manufacturer.
b. Compressive Strength: 5000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M.
c. Flexural Strength: 1,200 psi (84 kg/cm2) at 28 days, when tested in accordance with ASTM C348.
d. VOC: 0 g/L.
e. Thickness: As required for application and in accordance with manufacturer's installation instructions.
f. Products:
1) ARDEX Engineered Cements; ARDEX K15: www.ardexamericas.com.
2) HPS North America/Schonox; SCHONOX ZM: www.hpsubfloors.com

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

A. Perform following operations in the order indicated:
1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
b. Removal of existing floor covering, unless noted for removal by Owner's Abatement Contractor.
2. Preliminary cleaning.
3. Moisture vapor emission tests; 3 tests in the first 1000 square feet (100 square meters) and one test in each additional 1000 square feet (100 square meters), unless otherwise indicated or required by flooring manufacturer.
4. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
5. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
6. Epoxy Moisture Mitigation System application for existing slab on grade installations.
7. Patching, smoothing, and leveling, as required.
a. On remodeling projects, assume 33% of area will require filling, patching or leveling.

3.02 REMOVAL OF EXISTING FLOOR COVERINGS

A. Comply with local, State, and federal regulations and recommendations of RFCI (RWP), as applicable to floor covering being removed.

B. Dispose of removed materials in accordance with local, State, and federal regulations and as specified.

3.03 PRELIMINARY CLEANING

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

3.04 MOISTURE VAPOR EMISSION TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F1869 and as follows.

D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet (1.4 kg per 93 square meters) per 24 hours.

F. Report: Report the information required by the test method.

3.05 INTERNAL RELATIVE HUMIDITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F2170 Procedure A and as follows.

D. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

F. Report: Report the information required by the test method.

3.06 ALKALINITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.07 PREPARATION

A. See individual floor covering section(s) for additional requirements.

B. Comply with requirements and recommendations of floor covering manufacturer.

C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.

1. Achieve a substrate that is flat to within 1/8” in 10’.

3.08 ADHESIVE BOND AND COMPATIBILITY TESTING

A. Comply with requirements and recommendations as noted in Part 1 of this specification under CONCRETE MOISTURE AND ADHESION.

3.09 APPLICATION OF EPOXY MOISTURE MITIGATION SYSTEM.

A. Comply with requirements and recommendations of coating manufacturer.

END OF SECTION 09 05 61

SECTION 09 21 16
GYPSUM WALLBOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum wallboard assemblies.
B. Non load bearing rated and non-rated metal stud wall assemblies.
C. Metal channel ceiling framing.
D. Resilient sound hat channels and/or isolation clips.
E. Sound batt insulation.
F. Mold and moisture resistant gypsum wallboard on the inside face of exterior stud walls or on top of hat channels on exterior masonry/concrete walls.
G. Cementitious backing board "Cement Board" as a substrate for ceramic/porcelain tile with-in two feet (0.6096 m) horizontally of water closets and urinals on the wet wall or to an inside corner, whichever is greater. Cement board to be the same height as the tile. Coordinate exact transitions with the tile installer.
    1. As indicated on the drawings at other locations.
H. Tile backer board as a substrate for ceramic or porcelain tile.
I. Gypsum wallboard.
J. Joint treatment and accessories.
K. Acoustic sealant at stud walls at locations noted on the drawings.
L. Extruded Aluminum Partition Gap Closure.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on installation of acoustic spray system (including application thickness of spray).
C. UL listings for rated assemblies from manufacturer of framing/gypsum board products for:
    1. Rated gypsum wallboard partitions.
D. Samples of textured finishes.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling
    1. Deliver materials to the project site with manufacturer's labels intact and legible.
    2. Handle materials with care to prevent damage.
    3. Deliver fire-rated materials bearing testing agency label and required fire classification numbers.
    4. The plastic packaging used to wrap gypsum panel products for shipment is intended to provide temporary protection from moisture exposure during transit only and is not intended to provide protection during storage after delivery. Such plastic packaging shall be removed immediately upon receipt of the shipment.
    5. Failure to remove protective plastic shipping covers can result in condensation which can lead to damage, including mold.
B. Storage
    1. Store materials inside under cover, stack flat, properly supported on a level surface, all in same direction, off of floor. Gypsum panel products to be fully protected from weather, direct sunlight exposure and condensation. Gypsum materials with water damage shall be removed from the jobsite.
    2. Avoid overloading floor system
    3. Store adhesives in dry area; provide protection against freezing at all times.
    4. Steel framing and related accessories shall be stored and handled in accordance with AISI's "Code of Standard Practice".

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.
    1. See PART 3 for finishing requirements.

B. Interior Partitions, Indicated as Sound-Rated: Provide completed assemblies with the following characteristics:
   1. Acoustic Attenuation: As noted on wall types on the drawings.
C. Fire-Resistance-Rated Assemblies: Provide completed assemblies with fire ratings as noted on the drawings
   1. ICC IBC Item Numbers: Comply with applicable requirements of ICC IBC for the particular assembly.
   2. Gypsum Association File Numbers: Comply with requirements of GA-600 for the particular assembly.
   3. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.02 METAL FRAMING MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
B. Manufacturers - Metal Framing, Connectors, and Accessories:
   1. ClarkDietrich: www.clarkdietrich.com.
   2. Equivalent products by other manufacturers are acceptable.
C. Non-structural Framing System Components: ASTM C645; galvanized sheet steel (ASTM 645M G40 [Z120]), of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf (L/240 at 240 Pa).
   1. Studs: C-shaped with flat, knurled or embossed faces.
      a. Metal thickness:
         1) 20 gauge or ProSTUD 20 gauge equivalent.
         2) 25 gauge or ProSTUD 25 gauge equivalent.
      b. Size: 1-5/8 inch (41.275 mm), 2-½ inch (63.5 mm), 3-5/8 inch (92.075 mm), 4 inch (101.6 mm), 6 inch (152.4 mm) or 8 inch (203.2 mm) deep as noted on drawings.
   2. Runners: U shaped, sized to match studs.
   3. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch (22 mm).
   4. Furring Members: Zee-shaped sections, minimum depth of 1 inch (25 mm).
      a. Products:
         1) Same manufacturer as other framing materials.
   5. Resilient Furring Channels: Single or double leg configuration; 1/2 inch (13 mm) channel depth.
      a. Products:
         1) ClarkDietrich; RC Deluxe Resilient Channel: www.clarkdietrich.com.
   6. Resilient Sound Isolation Clips: Steel resilient clips with molded rubber isolators, attaches to framing; improves noise isolation performance of wall and floor-ceiling assemblies.
      a. Products:
         1) ClarkDietrich; Sound Clip (CDSC): www.clarkdietrich.com.
D. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and screwed to secondary deflection channel set inside but unattached to top track.
E. Non-structural Framing Accessories:
   1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
   2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
      a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
      b. Height: As required for wall height.
      c. Products:
         1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com.
F. Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.
   1. Products:
      a. USG Corporation; Drywall Suspension System: www.usg.com.

b. Rockfon Chicago Metallic Corporation; Drywall Furring 640/660: www.rockfon.com.
c. Armstrong World Industries; Drywall Suspension Systems: www.armstrongceilings.com.

2.03 WALLBOARD MATERIALS

A. Manufacturers:
1. Any manufacturers who comply with the specification are acceptable.

B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use only at soffits, gypsum wallboard on furring and partitions that do not go to structure.
2. Surface Paper: 100% recycled content paper on front, back and long edges.
3. Long Edges: Tapered; square edge acceptable at areas with Level 1 finish.
4. Thickness:
a. Vertical Surfaces: 5/8 inch (16 mm).
b. Soffit/Ceilings: 5/8 inch (16 mm).

C. Fire-resistant Rated Wallboard:
1. Application: For use at all locations and wallboard types unless noted otherwise in this specification.
2. Type: Fire-resistance-rated Type X or requirements of ASTM C 1396 Standard Specification for Gypsum Board, UL or WH listed.
3. Surface Paper: 100% recycled content paper on front, back and long edges.
4. Long Edges: Tapered; square edge acceptable at areas with Level 1 finish.
5. Thickness: 5/8 inch (16 mm).

D. Mold and Moisture Resistant Wallboard:
1. Application: Use at interior face of exterior stud walls, ceiling joists under attics and on furring attached to inside face of exterior masonry/concrete walls.
2. Surface Paper: Coated fiberglass mat on face, back and long edges.
3. Long Edges: Tapered; square edge acceptable at areas with Level 1 finish.
4. Humidified Deflection: Not more than ¼" when tested in accordance with ASTM C473 and C1658.
5. Water Absorption: Less than 5% of weight when tested in accordance with C1396M and C1658.
6. Mold/Mildew Resistance: 10 when tested in accordance with ASTM D 3273
7. Thickness: 5/8 inch (16 mm).

E. Cement Based Tile Backer Board "Cement Board"
1. Application:
a. Behind ceramic/porcelain tile with-in two feet (0.6096 m) of water closets and urinals.
b. Behind porcelain and ceramic tile in showers.
c. As a substrate for ACF Soffits.
d. Other locations as noted on the drawings.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
4. Water Absorption: Not greater than 8% when tested for 24 hours in accordance with ASTM C 473.
5. Glass Mat Faced Board for showers: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
a. Regular Type: Thickness 5/8 inch (16 mm).
b. Fire-Resistance-Rated Type: Type X core, thickness 5/8 inch (16 mm).

F. Gypsum Tile Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
1. Application: Vertical surfaces behind thinset tile, except in wet areas.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Permanence: Not more than 1.0 perms when tested in accordance with ASTM E96.
4. Humidified Deflection: Not more than ¼" when tested in accordance with ASTM C473 and C1178.
5. Water Absorption: Less than 5% of weight when tested in accordance with C1396M and C1178.

6. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
7. Type X Thickness: 5/8 inch (16 mm).
8. Regular Board Thickness: 5/8 inch (16 mm).
9. Edges: Tapered.

2.04 GYPSUM BOARD ACCESSORIES

A. Sound Batt Insulation: Refer to Section 07 21 00 Insulation for requirements.
B. Acoustic Spray System: Refer to Section 07 21 00 Insulation for requirements.
C. Acoustic Sealant: Conforming to ASTM C 919, Standard Practice for Use of Sealants in Acoustical Applications.
D. Beads, Joint Accessories, and Other Trim: ASTM C1047, aluminum coated, galvanized steel or rolled zinc, unless noted otherwise.
   1. Corner Beads: Low profile, for 90 degree outside corners.
   2. L-Trim with Tear-Away Strip: Sized to fit 5/8 inch (16 mm) thick gypsum wallboard.
   3. Expansion Joints:
      a. Type: V-shaped metal with factory-installed protective tape.
E. Extruded Aluminum Partition Gap Closure
   1. Mullion Mate Plus (Against the Glass) by Gordon, Inc
      a. Field Verify Lengths
      b. Dark Bronze color to match window frame.
F. Joint Materials: ASTM C475/C475Mand as recommended by gypsum wallboard manufacturer for project conditions.
   1. Interior Gypsum Wallboard:
      a. Paper Tape: 2 inch (50 mm) wide, creased paper tape for joints and corners.
   2. Glass-Matt Gypsum Wallboard:
      a. Fiberglass Tape: 2 inch (50 mm) wide, coated glass fiber tape for joints and corners.
   3. Other Panels:
      a. As recommended by wallboard manufacturer.
   4. Joint Compound for Interior Gypsum Wallboard: Drying type, vinyl-based, field-mixed or ready-mixed.
   5. Joint Compound for Glass-matt Gypsum Wallboard: As recommended by wallboard manufacturer.
G. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
H. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch (0.84 to 2.84 mm) in Thickness: ASTM C954; steel drill screws, corrosion-resistant.
I. Nails for Attachment to Wood Members: ASTM C514.
J. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.
K. Adhesive for Attachment to Masonry/Concrete,Wood, ASTM C557 and Metal:
   1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR, 59, Subpart D (EPA Method 24).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.
   1. If items need correction, contact the Construction Manager or General Contractor.
      a. Do Not proceed with installation until conditions have been corrected.

3.02 FRAMING INSTALLATION

A. Metal Stud Schedule:
   1. Use 25 gauge or equivalent knurled or embossed metal studs on partitions up to 12 feet (3.66 m) high and soffits.

2. Use 20 gauge or equivalent knurled or embossed metal studs on:
    a. Metal stud partitions over 12 feet (3.66 m) and less than 18 feet (5.49 m) high.
    b. Metal stud framed ceilings.
    c. Double studs at each door and borrowed light jamb and head up to 36 inches (914.4 mm) wide. For frame wider than 36 inches (914.4 mm) provide an additional full height stud at each jamb for every 32 inches (812.8 mm) of additional width.
    d. Two (2) - 16 gauge studs at mounting points of accessible grab bars, wall mounted accessible benches and diaper changing stations as occurs on stud walls.
    e. For partitions of any height covered with abuse or high impact resistant gypsum board.
    f. For partitions of any height covered with cement board.
3. Use 16 gauge or equivalent knurled or embossed metal studs on partitions over 18 feet (5.49 m) high.

B. Metal Framing: Install in accordance with ASTM C1007AISI S220 and manufacturer's instructions.

C. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
1. Level ceiling system to a tolerance of 1/8" in 10'-0" (3.175mm- 3.05M).
2. Suspend ceiling hangers from building structural members and as follows:
    a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum not part of supporting structural or ceiling suspension system.
    b. Splay hangers only where required to miss obstruction s and offset resulting horizontal forces by bracing, counter splaying or other equally effective means.
    c. Where widths of ducts and other construction within ceiling plenum produce hanger spacing that interfere with the location of hangers at spacing required to support standard suspension system members, install supplemental suspension system members and hangers in form of trapezes or equivalent devices.
        1) Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
    d. Secure wire hangers to structure, by looping or wire tying, directly to supporting structure, including intermediate framing members. Attach to inserts, eye screws, or other devices appropriate for structure to which hangers are attached as well as for type of hanger involved in manner that will not cause deterioration or failure, due to age, corrosion or elevated temperatures.
    e. Laterally brace entire suspension system.
    f. Do not attach hangers to metal roof deck or metal deck tabs.
    g. Do not connect or suspend steel framing from ducts, pipes or conduits.
    h. Keep hangers and braces 2 inches clear of ducts, pipes and conduits.
    i. Wire-tie or clip furring members to main runners and to other structural supports.
    j. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension system abuts vertical surfaces. Mechanically join main beam and cross furring members to each other and butt cut to fit wall track.
    k. Where suspended ceiling assemblies abut building structure horizontally at ceiling perimeters or penetrations of ceiling.
    l. Install bracing as required at exterior locations to resist wind uplift.

D. Studs: Space studs at 16 inches on center (at 406 mm on center).
1. Extend partition framing as indicated on the drawings.
2. Where studs or runners are installed directly against masonry walls or concrete floors/walls, set studs in acoustical sealant.
3. Installation Tolerances: Install each steel framing and furring member so that fastening surface does not vary more than 1/8 inch (3.175 mm) from plane of faces of adjacent framing.

4. Ensure that steel framing is isolated from building structure to prevent transfer of loading imposed by structural movement, at location indicated below to comply with details shown on drawings.
    a. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

E. For STC-rated or fire-resistance rated partitions that extend full height, install framing around structural members, as required to support gypsum board closures needed to make partitions continuous from floor to underside of structure above.

F. Brace partition framing, not extending full height to structure above, with studs same size and thickness as partition framing. Provide bracing at:
    1. 6 foot (1.8288 m) o.c. intervals along length of partitions.
    2. Not less than 6 foot (1.8288 m) from partition ends and corners.
    3. Door and window openings.

G. Do not bridge building expansion and control joints with steel framing or furring members, independently frame both sides of joints with framing or furring members or as indicated.

H. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
    1. Frame door openings to comply with details indicated, with GA-219 and with applicable published recommendations of gypsum wallboard manufacturer. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

I. Standard Wall Furring: Install at concrete and masonry walls scheduled to receive gypsum wallboard, not more than 4 inches (100 mm) from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches (600 mm) on center.
    1. Orientation: Vertical.
    2. Spacing: At 16 inches on center (At 400 mm on center).

J. Acoustic Furring: Install resilient channels at maximum 24 inches (600 mm) on center. Locate joints over framing members.

K. Resilient Sound Isolation Clips: Install resilient sound isolation clips, and where applicable, associated furring sections and channels, in accordance with clip manufacturer's written instructions.

L. Furring for Fire-Resistance Ratings: Install as required for fire-resistance ratings indicated and to GA-600 requirements.

M. Blocking: Comply with details indicated and with recommendations of gypsum wallboard manufacturer.
    1. Install mechanically fastened steel sheet blocking or plywood blocking for support of:
        a. Framed openings.
        b. Wall-mounted cabinets.
        c. Plumbing fixtures.
        d. Toilet partitions.
        e. Toilet accessories.
        f. Wall-mounted door hardware.
        g. Marker and Tack Boards.
        h. Handrails.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
    1. Place one bead continuously on substrate before installation of perimeter framing members.
    2. Place continuous bead at perimeter of each layer of gypsum wallboard.

3.04 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Do Not install imperfect, damaged or damp/wet/water damaged boards.

C. Single-Layer Nonrated: Install gypsum wallboard perpendicular to framing on walls 8 feet -1 inch (2.46379 m) or less in height with ends and edges occurring over firm bearing.

1. Exception: Tapered edges to receive joint treatment at right angles to framing.

D. Double-Layer, Nonrated: Use gypsum wallboard for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.

E. Fire-Resistance-Rated Construction: Install gypsum wallboard in strict compliance with requirements of assembly listing.

F. Spot grout hollow metal door frames for solid core wood doors, hollow metal doors and doors over 32 inches wide except where full grout is shown. Apply spot grout at each jamb anchor clip just before inserting board into frame.

G. Form control joints and expansion joints at locations indicated or as recommended, with space between edges of boards, prepared to receive trim accessories.

1. Where a control joints occurs in an acoustical or fire-rated system, blocking shall be provide behind the control joint by using a backing material such as 5/8 inch (15.875 mm) type X gypsum panel product, or other tested equivalent.

H. Cover both faces of metal stud partition framing with gypsum board in concealed spaces (above ceiling, etc.), except in chase walls which are braced internally.

I. Except where concealed application is indicated or required for sound, fire, air or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq.ft. (0.74322 sq. m.) area, and may be limited to not less than 75 percent of full coverage.

J. Fit gypsum wallboard around ducts, pipes and conduits.

K. Isolate perimeters of non-load-bearing drywall partitions at structural abutments. Provide ¼ to ½ inch (6.35 to 12.7 mm) space to accept trim edge.

L. Where STC-rated gypsum wallboard assemblies are indicated or drawings indicate acoustical sealant, seal construction at perimeters, behind control and expansion joints, openings, and other penetrations with a continuous bead of acoustical sealant. Include a bead of sealant at both faces of partitions.

M. Comply with ASTM C 919 and manufacturer’s recommendations for location of edge trim and closing off sound flanking paths around or through gypsum wallboard assemblies, including partitions extending above ceilings.

N. Where resilient furring channels are used over steel framing, the screws used to attach the gypsum panel product to the furring channels shall not contact the framing.

O. Gypsum panel products applied to walls shall be applied with the bottom edge spaced a minimum of 1/8 inch (3.175 mm) and maximum of ¼ inch (6.35 mm) above the floor.

P. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum wallboard), comply with gypsum wallboard manufacturer’s written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

Q. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

R. Installation on Wood Framing: For rated assemblies, comply with requirements of listing authority. For nonrated assemblies, install as follows:

1. Single-Layer Applications: Adhesive application.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
   1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
   2. At exterior soffits, not more than 30 feet (10 meters) apart in both directions.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum wallboard abuts dissimilar materials.
   1. Allow for a 3/8 inch (9.525 mm) gap to apply a sealant joint when indicated on the drawings.

3.06 JOINT TREATMENT

A. Glass Mat Faced Gypsum Wallboard: Use fiberglass joint tape, embed and finish with setting type joint compound.

B. Paper Faced Gypsum Wallboard: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

C. Finish gypsum wallboard in accordance with levels defined in ASTM C840, as follows:
   1. Level 5:
      a. All joints and interior angles shall have tape embedded in joint compound and two separate coats for joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat of joint compound trowel applied, or a material manufactured especially for this purpose and applied in accordance with manufacturer's recommendations, shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges. When necessary, sand between coats and following final coat to provide smooth surface ready for decoration.
      b. For use on:
         1) All ceilings.
         2) Walls and/or soffits under skylights and clerestories.
         3) Walls with glass faced board, and as noted on drawings.
         4) Recoating walls where wallcovering has been removed.
      c. When Level 5 finish is used, it shall extend to nearest inside or outside corner.
   2. Level 4:
      a. All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges. When necessary, sand between coats and following final coat to provide smooth surface ready for decoration.
      b. For use on:
         1) Walls scheduled for paint or wallcovering except those areas noted under Level 3 and 5.
   3. Level 3:
      a. All joints and interior angles shall have tape embedded in joint compound and one additional coat of joint compound applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges.
      b. For use on surfaces of mechanical and electrical spaces scheduled to receive paint.
         1) Surfaces of mechanical and electrical spaces scheduled to receive paint.
      c. For use on surfaces to receive texture finish.

4. Level 2: All joints and interior angles shall have tape embedded in joint compound and wiped with a joint knife leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.
    a. All joints and interior angles shall have tape embedded in joint compound and wiped with a joint knife leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.
    b. For use on:
        1) Substrates for tile
        2) Substrates for wood paneling.
5. Level 1/Fire Taping:
    a. All joints and interior angles shall have tape set in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable. Tape and fasteners need not be covered.
    b. For use on:
        1) For use in plenum areas above ceilings.
        2) Gypsum wallboard not scheduled for paint or wallcovering.
        3) Gypsum wallboard concealed from view in the finished work, except as noted in level 2.

3.07 FINISHING ADJUSTMENT

A. Screw Pop
    1. Repair nail pop by driving new screw approximately 1-1/2 inches away and reseat screw.
    2. When face paper is punctured drive new screw approximately 1-1/2 inches from defective fastening and remove defective fastening.
    3. Fill damaged surface with compound in coats specified by required finish level.
B. Ridging
    1. Sand ridges to reinforcing tape without cutting through tape.
    2. Fill concave areas on both sides of ridge with topping compound.
    3. After fill is dry, blend in topping compound over repaired area.
C. Fill cracks with compound and finish smooth and flush.

3.08 TOLERANCES

A. Maximum Variation of Finished Gypsum Wallboard Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

3.09 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.
B. Protect installed products from damage from weather, condensation, construction, and other causes during remainder of the construction period.
C. Remove and replace panels that are wet, moisture damaged, or mold damaged.
D. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
E. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 21 16

SECTION 09 24 00
PORTLAND CEMENT PLASTER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cement plastering patching in Area A.
B. Accessories.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide data on plaster materials and trim accessories.
C. Shop Drawings: Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.
D. Samples:
   1. Submit two samples, 12 by 12 inch (304.8 by 304.8 mm) in size illustrating finish color and texture.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with minimum ten years documented experience.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver manufactured materials in original unopened packages or containers, with manufacturer's label intact and legible.
B. Keep plaster materials dry, store off the ground, covered, and away from damp surfaces.
C. Remove wet and deteriorated materials from site.

1.05 FIELD CONDITIONS

A. Interior Plaster Work: Maintain minimum ambient temperature of 50 degrees F (10 degrees C) during installation of plaster and until fully cured.

PART 2 PRODUCTS

2.01 CEMENT PLASTER APPLICATIONS

A. Lath Plaster Base: Metal lath.
   1. Plaster Type: Jobsite mixed plaster.
   2. First Coat: Apply to a nominal thickness of 3/8 inch (9 mm).
   3. Plaster Second Coat: Apply to a nominal thickness of 1/4 inch (6.35 mm).
   4. Plaster Finish Coat: Apply to a nominal thickness of 1/8 inch (3 mm).

2.02 JOBSITE MIXED CEMENT PLASTER

A. Materials:
   1. Portland Cement: ASTM C150/C150M, Type I.
      a. Finish Coat: White color.
   2. Masonry Cement: ASTM C91/C91M, Type N.
   3. Lime: ASTM C206 Type S.
   4. Silica Sand: Clean, well graded as follows:

Sieve	% Passing
No. 16	100
No. 30	50-80
No. 50	30-50
No. 100	0-20

   5. Water: Clean, fresh, potable, and free of mineral or organic matter that could adversely affect plaster.
   6. Admixture: liquid acrylic polymer and modifier type.
   7. Plaster Mix Reinforcement: Glass fibers, chopped to 1/2 inch (13 mm) nominal length, and alkali resistant.
B. Plaster/Stucco Mixes:
   1. Liquid in all coats: 3 parts water and 1 part add mixture.

2. Scratch coat:
    a. 1 part portland cement.
    b. 1 part masonry cement.
    c. 1 ½ to 2 ½ pounds fiber.
    d. 4 parts aggregate.
3. Brown coat:
    a. 1 part portland cement.
    b. 1 part masonry cement.
    c. 1 ½ to 2 ½ pounds fiber.
    d. 5 parts aggregate.
4. Plaster Finish Coat:
    a. 1 part white cement.
    b. 1/4 part lime.
    c. 3 parts silica sand.

2.03 ACCESSORIES

A. Lath:
1. Self-furring metal lath: 3.4 lb./sq.yd. galvanized steel diamond self-furring expanded metal conforming to ASTM C847.
2. Metal Lath Alternate: Grid shaped, self-furred, welded wire lath, formed from cold rolled rectangular longitudinal wires with coated thickness dimensions of 0.0330 inch (0.83 mm) by 0.075 inch (1.90 mm), and round cross wires having a coated diameter of 0.056 inch (1.42 mm), resistance welded at the intersections. Galvanized coating complying with ASTM A641. Minimum nominal weight 1.95 pounds per square yard (1.05 kg/m2).
    a. Manufacturer:
        1) Structa Wire Products: MegaLath; www.structawire.com.
        2) Equivalent products by other manufacturers are acceptable.
3. Paper-backed metal lath for stucco: 3.4 lb. galvanized steel diamond flat expanded metal, with asphalt impregnated paper adhered to the backside.

B. Finishing Accessories: ASTM C1063; galvanizd steel sheet ASTM A924/A924M G90 or rolled zinc, unless noted otherwise.
1. Types: As detailed or required for finished appearance.
2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed plaster edges.
3. Products:
    a. Stockton Products: www.stocktonproducts.com.
    b. Keene Building Products: www.keenebuilding.com.

C. Framing and Suspension System
1. Hanger wire: #9 (6.63 sq mm) gauge (Class I) galvanized wire.
2. Carrying channels: 1-1/2 inch (38.1 mm) cold-rolled steel.
3. Furring channels: 3/4 inch (19.05 mm) cold rolled furring channel, attached with #18 (0.82 sq mm) tie wire.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions are acceptable prior to starting this work.

B. Verify masonry joints are flush and surfaces are ready to receive work of this section, and that there are no existing bituminous or water repellent coatings on masonry surfaces.

C. Verify concrete surfaces are flat, honeycombs are filled flush, and surfaces are ready to receive work of this section, and that there are no existing bituminous, water repellent, or form release agent coatings on concrete surfaces that may be detrimental to plaster bond.

D. Verify lath is flat, secured to substrate, and joint and surface perimeter accessories are properly in place.
E. Verify mechanical and electrical equipment and services located within areas to receive this work have been properly tested and approved.

3.02 PREPARATION

A. Dampen masonry surfaces to reduce excessive suction.
B. Clean concrete surfaces of foreign matter using approved acid solutions, solvents, or detergents, and then rinse surfaces thoroughly with clean water.
C. Roughen smooth concrete surfaces and apply bonding compound in accordance with manufacturer's written installation instructions.
D. Apply dash bond coat of plaster to solid bases and moist cure for at least 24 hours before applying first coat of jobsite mixed plaster.

3.03 SUSPENSION SYSTEM/LATH FOR CEMENT PLASTER CEILINGS AND SOFFITS

A. Install 1-1/2 inch (38.1 mm) furring channels, at 36 inch (914.4 mm) o.c. with 9 gauge (6.63 sq mm) hangar wire hung 48 inch (1219.2 mm) x 36 inch (914.4 mm) on center. Tie 3/4 inch (19.05 mm) cross furring channels at 16 inch (406.4 mm) o.c. Tie on lath.
B. Isolate ceiling/soffit assemblies where they abut or are penetrated by building structure. Do not bridge building control and expansion joints with framing. Frame both sides of joints independently.
C. Suspend ceiling hangers from building structure as follows:
    1. Install hangers plumb and free of contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.
    2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to limit deflection to 1/360 of span while supporting ceiling loads.
    3. Wire Hangers: Secure by looping and tying, either directly to structure or directly to fasteners that are secure and appropriate for substrate, in a manner that will not cause them to deteriorate or otherwise fail.

3.04 INSTALLATION- LATH FOR WALLS

A. On exterior walls, install stucco wrap (over weather barrier by others) horizontally and plumb with grooved surface pattern in vertical position. Attach to studs with fasteners at 12-18 inch (304.8-457.2 mm) on center (at masonry, temporarily attach with adhesives). Install shingle style with minimum 6 inch (152.4 mm) overlap and all seams taped. Seal to base screed with caulk or tape.
B. Attach lath to framing or substrate according to ASTM C1063, lapping sides not less than ½ inch and ends not less than one inch.

3.05 INSTALLATION- ACCESSORIES

A. Install metal plaster or stucco accessories per ASTM C1063. Attach to lath with wire ties 6 inches (152.4 mm) o.c.
B. Install control joints (whether or not shown on drawings) to create panels relatively square, not larger than 144 square feet (13.3780 sq m) [on vertical surfaces] or 100 square feet (9.290 sq m)[on horizontal surfaces], and with no dimension exceeding 18 feet (5.4864 m) or a length to width ratio of 2:1.
    1. Locate vertical control joints at surface penetrations (windows, doors, louvers, etc.) and at areas of structural stress.
    2. Locate horizontal control at all penetrations (light fixtures, diffusers, columns, etc.) and at areas of potential cracking.

3.06 MIXING

A. Mix only as much plaster as can be used prior to initial set.
B. Mix materials dry, to uniform color and consistency, before adding water.

C. Do not retemper mixes after initial set has occurred.
D. Protect mixtures from frost or freezing temperatures, contamination, and excessive evaporation.

3.07 APPLICATION

A. Apply plaster in accordance with manufacturer's written instructions and comply with ASTM C926.
B. Scratch Coat:
   1. Apply scratch coat(s) to fully embed lath and to specified thickness.
   2. Follow guidelines in ASTM C926 and manufacturer's written installation instructions for moist curing base coats and application of subsequent coats.
C. Brown Coat:
   1. Apply brown coat to specified thickness.
D. Finish Coats:
   1. Cement Plaster:
      a. Apply with sufficient material and pressure to ensure complete coverage of base to specified thickness.
      b. Apply desired surface texture while mix is still workable.
      c. Float to a consistent finish.
E. After finishing last coat, point up and patch plastering, rake out surfaces where necessary, point up around trim and other adjoining work and leave surfaces complete and uniform at final completion.

3.08 TOLERANCES

A. Maximum Variation from True Flatness: 1/4 inch in 10 feet (6 mm in 3 m).

3.09 REPAIR

A. Patching: Remove loose, damaged or defective plaster and replace with plaster of same composition; finish to match surrounding area.

END OF SECTION 09 24 00

SECTION 09 30 00
TILE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Floor preparation as specified in Section 09 05 61 - Common Work Results for Flooring Preparation:
   1. Substrate Prep and Patching.
   2. Moisture Vapor Reduction Admixture (MVRA) in new slabs.
B. Tile for floor applications.
   1. Porcelain Tile (TILE-_).
   2. Decorative Tile:
      a. Mosaic (TILE-_).
C. Tile for wall applications.
   1. Porcelain Tile (TILE-__).
   2. Decorative Tile:
      a. Mosaic (TILE-_).
D. Mortar bed installations in toilets, showers and other areas shown on the drawings over depressed substrates.
E. Accessories.
   1. Metal trim at outside corners and top of wainscot.
   2. Metal coved base.
   3. Caulking of inside corners of tile.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene at least three weeks before starting work of this section to discuss conformance with the requirements of specification and job site conditions.
B. Required attendance by:
   1. Representatives of Owner, Architect, General Contractor or Construction Manager, Tile Subcontractor, Tile Manufacturer, Installation System Manufacturer (required to maintain warranty), Plumbing subcontractor and any other parties who are involved in the scope of this installation must attend the meeting.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
D. Samples:
   1. Submit one set of tile samples for Architects review and one set of samples for use by the Construction Manager/General Contractor for the jobsite trailer.
   2. Submit grout samples for selection by Architect, unless the colors indicated on the Interior Material Finish Schedule are being used.
   3. Submit samples of sealant colors that match grout colors.
E. Submit documentation to the Construction Manager/General Contractor to have on file at the jobsite trailer, confirming that the waterproofing membrane used in toilet rooms/showers are in compliance with the local plumbing code.
F. Master Grade Certificate: Submit for each type of tile, signed by the tile manufacturer and tile installer indicating compliance with TCA 137.1.
G. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

1.04 QUALITY ASSURANCE

A. Maintain one copy of ANSI A108/A118/A136 and TCNA (HB) on site.
B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with a minimum ten years of documented experience.

1.05 FLOOR FLATNESS

A. For new concrete slabs on grade and elevated structural slabs/topping as specified in Section 03 30 00 floor flatness is specified per ACI 117 as follows:
   1. F (F) Flat tolerance with an overall value of 35 and a minimum localized value of 21.
   2. F (L) Flat tolerance with an overall value of 25 and a minimum localized value of 15.
   3. Measured by a manual straightedge method a “flat” floor surface classification, maximum gap for 90% compliance, samples not to exceed ¼” and for 100% compliance, samples not to exceed 3/8”.

B. The flooring contractor will be responsible to provide the necessary means (i.e., grinding/leveling) for additional leveling as required by the flooring manufacturer.

1.06 MOCK-UPS

A. Construct tile mock-up for each type/style/finish/size/color, incorporating all components specified.
   1. Approved mock-up may remain as part of work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install solvent-based products in an unventilated environment.

B. Maintain ambient and substrate temperature above 50 degrees F (10 degrees C) and rising and below 100 degrees F (38 degrees C) during installation and curing of setting materials.

1.09 WARRANTY

A. The manufacturer of adhesives, mortars, grouts, and other installation materials shall provide a written twenty-five (25) year warranty, which covers materials and labor; reference Manufacturer Warranty Data Sheet for complete details and requirements.

B. For exterior facades over steel or wood framing, the manufacturer of adhesives, mortars, grouts and other installation materials shall provide a written ten (10) year warranty, which covers replacement of Manufacturer products only – reference Warranty Data Sheet for complete details and requirements.

PART 2 PRODUCTS

2.01 TILE

A. Manufacturers: All products of each type by the same manufacturer.

B. Manufacturers listed in this specification are approved under the following conditions:
   1. A manufacturer listed in both the specification and the Interior Material Finish/Color Schedule, on Architectural Drawings is not required to submit a pre-bid approval.
   2. Manufacturers listed in this specification, but not in the Interior Material Finish/Color Schedule, on Architectural Drawings shall submit color samples for pre-bid approval by addendum. Refer to Substitution Section 01 25 00.
   3. When no colors are listed in the Interior Material Finish/Color Schedule, on Architectural Drawings, any manufacturer listed in this specification are not required to submit a pre-bid approval.

C. Glazed Ceramic Wall Tile:
   1. Type: (TILE-4 and 5)
      a. Manufacturer: See Interior Material Finish/Color Schedule, on Architectural Drawings.
      b. Product: See Interior Material Finish/Color Schedule, on Architectural Drawings.
      c. Size: See Interior Material Finish/Color Schedule, on Architectural Drawings.
      d. Colors: See Interior Material Finish/Color Schedule, on Architectural Drawings.
      e. Pattern: As indicated on the drawings.

D. Porcelain Tile:
   1. Type: Porcelain Tile (TILE-1, 3, 6, and 7)
      a. Manufacturer: See Interior Material Finish/Color Schedule, on Architectural Drawings.
      b. Product: See Interior Material Finish/Color Schedule, on Architectural Drawings.
      c. Size: See Interior Material Finish/Color Schedule, on Architectural Drawings..
      d. Colors: See Interior Material Finish/Color Schedule, on Architectural Drawings.
      e. Pattern: As indicated on the drawings.
      f. Trim Units: Schluter Dilex AHK cove

E. Decorative Tile:
1. Type: Decorative Tile (TILE-2)
a. Manufacturer: See Interior Material Finish/Color Schedule, on Architectural Drawings.
b. Product: See Interior Material Finish/Color Schedule, on Architectural Drawings.
c. Size: 2 by 2 inch (51 by 51 mm), nominal.
d. Shape: Square.
e. Surface Finish: Unglazed.
f. Colors: See Interior Material Finish/Color Schedule, on Architectural Drawings.
g. Trim Units: Schluter Dilex AHK cove

F. Extra Tile Products
1. Furnish 1% of each type/shape//color of tile used on this project to Owner as maintenance stock.

2.02 SETTING MATERIALS

A. Provide setting and grout materials from the same manufacturer.

B. Manufacturers:
1. ARDEX Engineered Cements: www.ardexamericas.com.
2. Bostik Inc: www.bostik.com.
3. Custom Building Products: www.custombuildingproducts.com.
4. H.B. Fuller Construction Products, Inc: www.tecspecialty.com.
5. LATICRETE International, Inc: www.laticrete.com.
6. Mapei Corporation: www.mapei.com

C. Flooring Installations
1. Waterproofing on floors of showers (slab on grade), toilet rooms (slab on grade and above grade) and locker rooms on above grade locations meeting ANSI A118.10 & A118.12. (TCNA F121 or F122). Waterproofing membrane shall be in compliance with Uniform Plumbing Code (UPC) and International Plumbing Code (IPC):

Ardex:	8+9
Bostik:	Ultra-set Advanced or Gold Plus
Custom:	RedGard
Laticrete:	HYDRO BAN
Mapei:	Mapelastic AquaDefense and Mapebond
TEC:	Hydra-Flex Membrane

2. Waterproofing on floors of showers (above grade) meeting ANSI A118.10 & A118.12. Waterproofing membrane shall be in compliance with Uniform Plumbing Code (UPC) and International Plumbing Code (IPC). (TCNA F121 or F122):

Ardex:	8+9 & SK Mesh
Bostik:	Blacktop and Anti Fracture membrane or Gold Plus and Reinforcing Tape
Custom:	9240 Waterproofing & Anti-Fracture Membrane
Laticrete:	9235 Waterproofing & reinforcing fabric
Mapei:	Mapelastic AquaDefense and Reinforcing Fabric
TEC:	Hydra-Flex Membrane and Waterproofing Mesh

3. Setting bed for tile on concrete slabs-on-grade, mortar bed. Polymer modified mortar meeting ANSI A118.4, A118.11 and A118.15 (TCNA F111 or F113):

Ardex:	X 77 MICROTEC
Bostik:	BAM
Custom:	ProLite
Laticrete:	254 Premium
Mapei:	Ultraflex 3
TEC:	SuperFlex

4. Setting bed for large format tile, >15” in any direction on concrete slabs-on-grade, mortar bed. Polymer modified MORTAR meeting ANSI A118.4, A118.11 and A118.15 (TCNA F111 or F113):
    - Ardex: X 78 MICROTEC
    - Bostik: BAM
    - Custom: ProLite
    - Laticrete: 257 Titanium
    - Mapei: Ultraflex LFT
    - TEC: Isolight

D. Vertical Installations
1. Setting bed for tile on vertical substrates meeting ANSI A118.4, A118.11 and A118.15 (TCNA W245):
    - Ardex: X 77 MICROTEC
    - Bostik: BAM
    - Custom: ProLite (Interior), ProLite + RedGard (Exterior)
    - Laticrete: 254 Platinum
    - Mapei: Ultraflex 3
    - TEC: 3N1 Performance
2. Setting bed for tile in showers meeting ANSI A118.4E, A118.11 and A118.15 (TCNA W244C/W245):
    - Ardex: X 77 MICROTEC with E 90 Mortar Admix
    - Bostik: BAM with Gold Plus
    - Custom: ProLite
    - Laticrete: 254 Platinum with 333 Super Flexible Additive
    - Mapei: Ultraflex 3
    - TEC: Ultimate 6 Plus over Hydra-Flex
3. Setting tile over existing glazed tile/well bonded painted surfaces meeting ANSI A118.4 and A118.11 (TCNA TR713):
    - Ardex: X 77 MICROTEC over P51
    - Bostik: Stonewall over TOTAL Prime
    - Custom: VersaBond Fortified Thin-Set Mortar over MBP-Multi-Surface Bonding Primer
    - Laticrete: 257 Titanium over PRIME-N-BOND
    - Mapei: Ultraflex LFT over ECO Prim grip
    - TEC: Ultimate 6 Plus over Multipurpose Primer
4. Setting bed for tile large format tile, >15” in any direction meeting ANSI A118.4, A118.11 & A118.15 (TNCA F121 or F122):
    - Ardex: X 77 MICROTEC
    - Bostik: BAM
    - Custom: ProLite (Interior), ProLite + RedGard (Exterior)
    - Laticrete: SELECT-BOND
    - Mapei: Ultraflex LFT
    - TEC: Ultimate 6 Plus
5. Setting bed for Decortive (glass) tiles meeting ANSI A118.4 & A118.11 (TNCA W245):
    - Ardex: S 48
    - Bostik: Glass-Mate
    - Custom: Glass Tile Premium Thin-Set Mortar
    - Laticrete: Glass Tile Adhesive Lite
    - Mapei: Adesilex P10 with Keraply
    - TEC: Ultimate 6 Plus or SuperFlex or IsoLight

E. Mortar Bed: Mixture of portland cement and sand, roughly in proportions of 1:5 with latex polymer as the liquid portion of the mixture.
   1. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
   2. Reinforcing: Galvanized, welded wire fabric, 2 by 2 inches by 0.062 inch diameter; comply with ASTM A 185 and ASTM A82 except for minimum wire size.

2.03 GROUTS

A. Provide setting and grout materials from the same manufacturer.
B. Manufacturers:
   1. LATICRETE International: www.laticrete.com.
   2. Mapei Corporation: www.mapei.com.
C. For wall and floor tile grout, pre-mixed urethane grout:

Bostik:	TruColor RapidCure
Laticrete:	SPECTRALOCK
TEC:	AccuColor EFX

D. Colors: See Interior Material Finish/Color Schedule, on Architectural Drawings.

2.04 MAINTENANCE MATERIALS

A. Tile Sealant: Gunnable, silicone; moisture and mildew resistant type.
   1. Custom color to match tile grout color.

2.05 ACCESSORY MATERIALS

A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
   1. Crack Resistance: No failure at 1/8 inch (3.2 mm) gap, minimum.
   2. Fluid or Trowel Applied Type with Reinforcing membrane:
B. Cleaners: As recommended by tile and/or grout manufacturers.
C. Provide leveling system for tiles over 24” in any dimension as recommended by tile manufacturer.
D. Metal Trim for Tile:
   1. Manufacturers:
      a. Schluter Systems: www.schluter.com.
   2. Provide, splice connectors, end caps, inside and outside corners as warranted by application.
   3. Products:
      a. CT Corner Trim: (For use at outside corners of tile to tile and terminations of ceramic/porcelain tile to other materials).
         1) Manufactuer/Product:
            (a) Schluter QUADEC profile Q x tile height.
         2) Aluminum Finish:
            (a) Satin anodized.
      b. Wainscot Trim: (For use at the top of all wainscot tile).
      c. Manufactuer/Product:
         1) Schluter QUADEC profile Q x tile height.
      d. Aluminum Finish:
         1) Satin anodized.
      e. CT Transition Strip (For use with Carpet, SV or LVT to Ceramic/Porcelain Transition):
         1) Manufactuer/Product:
            (a) Schluter SCHIENE x tile height.
         2) Aluminum Finish:
            (a) Satin anodized.

f. CT Coved Base Trim (For use with new floor tile to new wall tile):
1) Manufactuer/Product:
(a) Schluter DILEX-AHK x tile height.
2) Aluminum Finish:
(a) Satin anodized.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
C. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.
D. Verify that required floor-mounted utilities are in correct location.
E. Commencement of work implies acceptance of surface and assumption of responsibility for satisfactory results.

3.02 PREPARATION

A. Protect surrounding work from damage.
B. Vacuum clean surfaces and damp clean.
C. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.
D. Existing Surface Preparation: Completely remove all paint, soap scum, wax, coatings, oil, etc. from existing surfaces to receive tile. Perform mechanical abrasion with a carborundum disk followed by a clear water wash. Use other cleaning methods of soapless detergents, commercial tile cleaners or solvents or acids if required to adequately prep surfaces. Substrate must be thoroughly rinsed and dry before setting the new tile.

3.03 INSTALLATION - GENERAL

A. Install crack isolation membrane over minor cracks and non-structural slab joints to prevent transmission of cracking to tile. Strictly follow membrane and mortar manufacturers' printed instructions.
1. For tile being installed on existing slabs on remodeling projects, assume 10 lineal feet of cracks requiring crack isolation membrane for every 50 square foot of area.
B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
E. Form internal angles square and external angles bullnosed.
F. Install ceramic accessories rigidly in prepared openings.
G. Install non-ceramic trim in accordance with manufacturer's instructions.
H. Install thresholds at transitions to adjacent materials to floor tile.
I. Sound tile after setting. Replace hollow sounding units.
J. Movement Joints.
1. Install joints to control the effects of substrate movement on tile finishes.
2. Construct joints in tile work according to movement joint details" EJ171" as published in TCNA "Handbook for Ceramic Tile Installation."
3. For tile being installed on existing slabs on remodeling projects, assume 20 lineal feet of movement joints for every 400 square foot of area (the joints around the 20' x 20' perimeter are to be included in additon to the 20 lineal foot assumption).
4. Locate movement joints at the following locations:
a. Interior: 20' to 25' maximum in each direction.
b. Exterior and Interior tile work exposed to direct sunlight or moisture: 8' to 12' maximum in each direction.

c. Where tile work abuts restraining surfaces including but not limited to perimeter walls, dissimilar floors, curbs, columns, pipes, ceilings, inside corners of abutting walls, and where changes occur in backing materials.
d. All expansion, control, construction, cold and seismic joints in the structure. Expansion joints in tile work must match width of joint in building structure.
e. Keep control and expansion joints free of mortar, grout, and adhesive.

K. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
L. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
M. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

A. Over exterior concrete substrates, install in accordance with TCNA (HB) Method F102, with standard grout.
B. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.
1. Use uncoupling membrane under all tile unless other underlayment is indicated.
2. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method and in accordance with manufacturer's instructions.

C. Over wood substrates, install in accordance with TCNA (HB) Method F142, with standard grout, unless otherwise indicated.
D. Install tile-to-tile floor movement joints in accordance with TCNA (HB) Method EJ171F.

3.05 INSTALLATION - FLOORS - MORTAR BED METHODS

A. Over exterior concrete substrates, install in accordance with TCNA (HB) Method F101, bonded, with standard grout.
B. Over interior concrete substrates, install in accordance with TCNA (HB) Method F111, with cleavage membrane, unless otherwise indicated.
C. Cleavage Membrane: Lap edges and ends.
D. Waterproofing Membrane: Install as recommended by manufacturer .
E. Maximum Mortar Bed Thickness: 2 inch (51 mm), unless otherwise indicated.

3.06 INSTALLATION - WALL TILE

A. On exterior walls install in accordance with TCNA (HB) Method W244, thin-set over cementitious backer units, with waterproofing membrane.
B. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.
C. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.
D. Over interior concrete and masonry install in accordance with TCNA (HB) Method W202, thin-set with dry-set or latex-Portland cement bond coat.

3.07 CLEANING AND PATCHING

A. Clean tile and grout surfaces.
B. Point open joints and replace defective work.

3.08 PROTECTION

A. Do not permit traffic over work in progress and over finished floor surface for 4 days after installation.
B. Finished tile floors: Covered with clean building paper before foot traffic is permitted on them. Place board walkways on floors that are to be continuously used as passageways by workers. Protect tiled vertical outside corners with board corner strips in areas used as passageways by workers.

END OF SECTION 09 30 00

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid acoustical ceiling system.
   1. Lay-in Acoustical.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
B. Do not install acoustical units until after interior wet work is dry.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on suspension system components and acoustical units.
C. Samples: Submit two samples 5-1/2 by 5-1/2 inch (139.7 by 139.7 mm) in size illustrating material and finish of acoustical units.
D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Acoustical Units: Quantity equal to 2 percent of total installed.

1.04 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.05 WARRANTY

A. Manufacturers standard 30 year warranty covering tile and grid systems which include:
   1. Red Rust Warranty
   2. Sag Warranty.
   3. Mold and Mildew Warranty

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acoustic Tiles/Panels:
   1. Armstrong World Industries, Inc: www.armstrongceilings.com.
   2. CertainTeed Corporation: www.certainteed.com.
   3. USG Corporation: www.usg.com/ceilings.
B. Suspension Systems:
   1. Armstrong World Industries, Inc: www.armstrongceilings.com.
   2. Rockfon/Chicago Metallic: www.rockfon.com.
   3. USG Corporation: www.usg.com/ceilings.
   4. CertainTeed Corporation[<>]: www.certainteed.com

2.02 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Rating: Determined in accordance with test procedures in ASTM E119.

2.03 ACOUSTICAL UNITS

A. Acoustical Units - General: ASTM E1264, Class A.
   1. VOC Content: Certified as Low Emission.
B. Lay-In Panels
   1. ACT 1 - NOT USED
   2. Acoustical Panels ACT 2: Painted mineral fiber, sag and abuse resistant, anti-microbial, low VOC with the following characteristics:
      a. Classification: ASTM E1264 Type III.
      b. Size: 24 by 24 inches (610 by 610 mm).
      c. Fire Rating: Class A with Flame Spread Index of 25 or less and Smoke Developed Index of 50 or less when tested in accordance with ASTM 85.
      d. Minimum NRC: 0.60, determined in accordance with ASTM E1264.
      e. Minimum Ceiling Attenuation Class (CAC): 40, determined in accordance with ASTM E1264.

f. Tile Edge: Square.
g. Color: White.
h. Suspension System: Exposed grid.
i. Products:
1) Basis of Design: USG Corporation 86270 Mars Healthcare Acoustical Panels with Climaplus: www.usg.com/ceilings.
2) Armstrong World Industries, Inc: www.armstrongceilings.com.
3) CertainTeed Corporation: www.certainteed.com.

3. ACT 3 - By 09 54 23 - Linear Metal Ceilings
4. Acoustical Panels ACT 4: 2 mil (0.0508 mm) vinyl laminated to a gypsum core, sag resistant, USDA approved, low VOC with the following characteristics:
a. Classification: ASTM E1264 Type XX.
b. Size: 24 by 24 inches (610 by 610 mm).
c. Thickness: 1/2 inches (12.7 mm).
d. Fire Rating: Class A with Flame Spread Index of 5 or less and Smoke Developed Index of 0 when tested in accordance with ASTM 85.
e. Minimum Ceiling Attenuation Class (CAC): 40, determined in accordance with ASTM E1264.
f. Tile Edge: Square.
g. Color: White.
h. Suspension System: Exposed grid.
i. Products:
1) CertainTeed Corporation; Vinylrock 1140-CRF-1: www.certainteed.com.
2) National Gypsum; Gridstone #Gold Bond Gridstone GB5045 (GB5044 for 24 inch by 24 inch): www.nationalgypsum.com
3) USG Corporation; Sheetrock Brand Gypsum Lay-In, ClimaPlus, #3270: www.usg.com/ceilings.

5. ACT 5 - By 09 54 23 - Linear Metal Ceilings

C. Furnish extra materials equal to 1%, but not less than one box, of each acoustical material supplied. Provide materials in new, unopened cartons, labeled as to contents.

2.04 SUSPENSION SYSTEM(S)

A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
1. Materials:
a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
b. Aluminum Grid Cap: Aluminum sheet, ASTM B209/B209M.

B. Exposed Suspension System: HDG-30 steel, hot dipped galvanized body and cap.
1. Application(s): Non-rated ceiling systems.
2. Application(s): Fire-rated assemblies.
3. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
4. Profile: Tee; 15/16 inch (24 mm) face width.
5. Finish: Baked enamel.
6. Color: White.
7. Non- Fire Rated Products:
a. Armstrong World Industries, Inc; Prelude ML: www.armstrongceilings.com.
b. Rockfon/Chicago Metallic; 250 Snap-Grid System: www.rockfon.com.
c. USG Corporation; Donn Brand DX24 : www.usg.com/ceilings.
d. Certainteed; EZ Stab Classic System: www.certainteed.com
e. Certainteed; EZ Stab Classic System: www.certainteed.com.
8. Fire Rated Products:
a. Armstrong World Industries, Inc; Prelude XL: www.armstrongceilings.com.
b. Rockfon/Chicago Metallic; 200 Snap-Grid System: www.rockfon.com.

c. USG Corporation; Donn Brand DX24 : www.usg.com/ceilings.
d. Certainteed; EZ Stab Classic System: www.certainteed.com.

2.05 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
B. Hanger Wire: 12 gauge, 0.08 inch (2 mm) galvanized steel wire.
C. Perimeter Moldings: Same metal and finish as grid.
1. Size: As required for installation conditions and specified Seismic Design Category.
2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
D. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

A. Install after major above-ceiling work is complete.
B. Coordinate the location of hangers with other work.

3.03 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
C. Locate system on room axis according to Reflected Ceiling Plan.
D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
1. Use longest practical lengths.
E. Suspension System: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
H. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.
I. Do not eccentrically load system or induce rotation of runners.
J. Install light fixture boxes constructed of rated acoustical panel above light fixtures in accordance with fire rated assembly requirements and light fixture ventilation requirements.

3.04 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.
B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
C. Fit border trim neatly against abutting surfaces.
D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
E. Cutting Acoustical Units:
1. Make field cut edges of same profile as factory edges.
F. Where round obstructions occur, provide preformed closures to match perimeter molding.

3.05 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).
B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION 09 51 00

SECTION 09 54 23
LINEAR METAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Linear metal ceilings.
   1. Non-perforated.
B. Suspended metal support system and perimeter trim.

1.02 DESIGN REQUIREMENTS

A. Design components to ensure light fixtures will not induce eccentric loads. Where components may induce rotation of ceiling system components, provide stabilizing reinforcement.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate work of this section with installation of mechanical and electrical components and with other construction activities affected by work of this section.
B. Pre-installation Meeting: Convene one week before starting work of this section.
C. Sequencing: Supply hanger clips during steel deck erection. Supply additional hangers and inserts as required.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Furnish for component profiles.
C. Shop Drawings: Indicate reflected ceiling plan, location of mechanical and electrical components, details of junction with dissimilar materials, points of suspension, and interface with building expansion joints.
D. Samples: Submit two samples 12 by 12 inch (304.8 by 304.8 mm) in size illustrating color and finish of exposed to view components.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Metal Ceiling Pan Units: Full-size units equal to 1 percent (1%) of amount installed.
   2. Ceiling Suspension System Components: Quantity of each grid and exposed component equal to 1 percent (1%) of amount installed.

1.05 QUALITY ASSURANCE

A. Environmental Limitations
   1. Do not install metal pan ceilings until after spaces are enclosed and weather tight and after wet work and work above ceilings is complete and accepted by project Architect. Do not store in unprotected space.
   2. Maintain environmental conditions within limits recommended by manufacturer for optimum results.
   3. Maintain within a temperature range of 50-100 degrees.
   4. Maintain within a 20%-60% relative humidity.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Sustainable Waste Management and Disposal for packaging waste requirements.
B. Accept factory-finished products on site in manufacturer's unopened factory packaging only; reject opened packages.
C. Protect factory-finished products from damage to appearance by storing products in manufacturer's unopened factory packaging in dry storage area.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Provide five year manufacturer warranty; include coverage for corrosion resistance and discoloration of surface finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Linear Metal Ceilings:
   1. Armstrong World Industries, Inc; METALWORKS Series: www.armstrongceilings.com.

2.02 LINEAR METAL CEILINGS

A. Linear Metal Ceiling System: Panels, suspension members, trim, and accessories as required to provide a complete system.

B. Performance Requirements:
   1. Design to support imposed loads of indicated items without eccentric loading of supports.
   2. Design for maximum deflection of 1/360 of span.
   3. Fire Performance: Class A
   4. Flame Spread: ASTM E 1264
   5. Systems Located Outside Building Envelope:
      a. Accommodate wind and suction loads and wind uplift without damage in accordance with applicable code.

2.03 COMPONENTS

A. Acoustical Ceiling Units:
   1. Acoustical Panels Type: ACT-3
      a. Armstrong METALWORKS Linear - Classics (Planks)
         1) 5490 4" Unperforated (M1)
         2) 96" x 4" x 5/8"
      b. Surface Texture: Smooth
      c. Composition: Electrogalvanized Steel 0.028"
      d. Color: To be selected from Manufacturer's Full Standard Range including Painted, Effects Classic, Sequels, Effects Bold and Effects Subtle.
   2. Acoustical Panels Type: ACT-5
      a. Armstrong METALWORKS Linear - Classics (Planks)
         1) 5490 4" Unperforated (M1)
         2) 96" x 4" x 5/8"
      b. Surface Texture: Smooth
      c. Color: Effects Subtle - Exterior Flax

B. Acoustical Backer: Manufacturer's standard non-woven fabric; as required to achieve specified acoustic performance.

C. Edge Molding, Expansion Joints, and Splices: Same material, thickness, and finish as linear panels.

D. End Caps: Formed metal; same color and finish as sight-exposed surfaces of linear panels.

E. Accessories: Stabilizer bars as required for suspended grid system; sight-exposed surfaces same color and finish as sight-exposed surfaces of linear panels.

F. Suspension Members: Formed steel sections, with integral attachment points; galvanized finish; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

G. Suspension Wire: Steel, annealed, galvanized finish, 9 gauge, 0.1144 inch (2.91 mm) diameter.

H. Subgirt Members: Hot-dip galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating; formed to resist imposed loads and to provide attachment for linear ceiling and accessories.

2.04 FABRICATION

A. Shop cut linear panels to accommodate mechanical and electrical items.

B. Factory-form internal and external corners of same material, thickness, finish, and profile to match exposed linear panels ; back brace internal corners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Verify that field measurements are as indicated.

3.02 INSTALLATION

A. Suspension Components:
   1. Install after above-ceiling work is complete in accordance with manufacturer's instructions, ASTM C636/C636M, and ASTM E580/E580M.
   2. Hang carrying members independent of walls, columns, ducts, light fixtures, pipe, and conduit; where carrying members are spliced, avoid visible displacement of face panels with adjacent panels.
   3. Where ducts or other equipment prevent regular spacing of hangers, reinforce nearest adjacent hangers to span the required distance.
   4. Locate suspension system for linear panel layout on room axis according to reflected plan.

B. Linear Metal Ceiling:
   1. Install linear panels and other system components in accordance with manufacturer's instructions.
   2. End joints:
      a. Stagger end joints minimum 12 inches (300 mm).
      b. Align end joints.
      c. Butt interior end joints tight.
   3. Set exterior end joints with 1/16 inch (2 mm) gap for expansion and contraction.
   4. Install filler strips between linear panels at exterior locations.
   5. Provide expansion joints to accommodate plus or minus 1 inch (25 mm) movement and maintain visual closure.
   6. Field miter corners at changes in panel direction.
   7. Install filler strips between linear panels at interior locations.
   8. Install edge moldings at junctions with other finishes and at vertical surfaces; use maximum piece lengths.
   9. Where bullnose masonry units occur, install radiused closures to fit edge molding.
   10. Install end caps at sight-exposed ends of linear panels.
   11. Exercise care when site cutting sight-exposed finished components to ensure surface finish is not defaced.

C. Insulation: Install above panel members; fit tight between grid members .

3.03 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

C. Maximum Variation From Dimensioned Position: 1/4 inch (6 mm).

3.04 CLEANING

A. Clean exposed surfaces.

B. Replace damaged or abraded components.

END OF SECTION 09 54 23

SECTION 09 65 00
RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Floor preparation as specified in Section 09 05 61 - Common Work Results for Flooring Preparation:
   1. Substrate Prep and Patching.
   2. Moisture Vapor Reduction Admixture (MVRA) in new slabs.
   3. Required Floor Flatness.
   4. Moisture Mitigation for Existing Slab on Grade.

B. Flooring types:
   1. Luxury Vinyl Tile and Planks (LVT)
   2. Vinyl Sheet Flooring (SV)

C. Resilient base.
   1. Base at freestanding or island casework.

D. Resilient stair accessories.

E. Installation accessories.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
   2. Provide data on substrate preparation materials.
      a. Materials for Substrate Prep and Patching.
      b. Visual Observation Report: For existing floor coverings to be removed.
      c. Epoxy Moisture Mitigation System Product Data: Manufacturer's published data on each product to be used for remediation.
         1) Manufacturer's qualification statement for training of Installer.
         2) Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.

C. Shop Drawings: Indicate floor patterns.

D. Verification Samples: Submit two samples, 3 by 3 inch (76.2 by 76.2 mm) in size illustrating color and pattern for each resilient flooring product specified.

E. Sample warranties for specified products noted in Warranty Paragraph below.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Provide 1% of each type/color of flooring, trim and base used on the project in original packaging.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.

B. Store all materials off of the floor in an acclimatized, weather-tight space.

C. Maintain temperature in storage area between 55 degrees F (13 degrees C) and 90 degrees F (72 degrees C).

D. Protect roll materials from damage by storing on end.

E. Do not double stack pallets.

1.04 FIELD CONDITIONS

A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F (21 degrees C) to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F (13 degrees C).

1.05 WARRANTY

A. Vinyl Sheet Flooring:
   1. Manufacturer's standard 10 year warranty.
   2. Manufacturer's standard 15 year warranty.

B. Luxury Vinyl Tile and Plank
   1. Manufacturer's standard 10 year warranty.
   2. Manufacturer's standard 20 year warranty.
   3. Manufacturer's standard 25 year warranty.

PART 2 PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Manufacturers listed in this specification are approved under the following conditions:
   1. A manufacturer listed in both the specification and the Interior Material Finish/Color Schedule, on the Drawings is not required to submit a pre-bid approval.
   2. Manufacturers listed in this specification, but not in the Interior Material Finish/Color Schedule, on the Drawings shall submit color samples for pre-bid approval by addendum.
   3. When no colors are listed in the Interior Material Finish/Color Schedule, on the Drawings, any manufacturer listed in this specification are not required to submit a pre-bid approval.

2.02 SHEET FLOORING

A. Vinyl Sheet Flooring - Type SV #-___: Homogeneous without backing, with color and pattern throughout full thickness.
   1. Manufacturers: See Material Finish/Color Schedule on the Drawings.
   2. Minimum Requirements: Comply with ASTM F1913.
   3. Thickness: 0.080 inch (2.0 mm) nominal.
   4. Integral coved base with cap strip.
   5. Pattern: See Material Finish/Color Schedule on the Drawings.
   6. Color: As indicated on drawings.

B. Vinyl Sheet Flooring - Type SV #-1: Heterogeneous commercial flooring having a PUR reinforced wear layer composed of 90% binder content, with a polyurethane reinforced (PUR) construction with heat welded seams.

C. Vinyl Sheet Flooring - Type SV #-2: Heterogeneous commercial flooring having a PUR reinforced wear layer composed of 90% binder content, with a polyurethane reinforced (PUR) construction with heat welded seams.

2.03 TILE FLOORING

A. Luxury Vinyl Tile - Type LVT #-1: Solid vinyl with color and pattern throughout thickness.
   1. Manufacturers: See Material Finish/Color Schedule on the Drawings.
   2. Minimum Requirements: Comply with ASTM F1700, of Class corresponding to type specified.
   3. Plank Tile Size: See Material Finish/Color Schedule on the Drawings.
   4. Wear Layer Thickness: See Material Finish/Color Schedule on the Drawings.
   5. Total Thickness: See Material Finish/Color Schedule on the Drawings.
   6. Collection/Pattern/Color: See Material Finish/Color Schedule on the Drawings.

2.04 RESILIENT BASE

A. Resilient Base: ASTM F1861, Type TV, vinyl, thermoplastic.
   1. Manufacturers:
      a. Johnsonite, a Tarkett Company: www.johnsonite.com.
   2. Height: 4 inches (100 mm)
   3. Thickness: 0.125 inch (3.2 mm).
   4. Finish: Matte.
   5. Length: Roll.
   6. Style: Coved.
   7. Corners: Provide prefabricated interior and exterior corners.
   8. Stringers at stairs: 10 inch (254 mm) high.
   9. Color: See Material Finish/Color Schedule on the Drawings.

2.05 ACCESSORIES

A. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.

B. Moldings, Transition and Edge Strips:

1. Manufacturers:
   a. Match resilient base manufacturer.
2. Transition/Reducer strips: See Material Finish/Color Schedule on the Drawings.
   a. Refer to accessories manufacturer for appropriate transition/reducer profile required for specified floor types.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

C. Contact the General Contractor or Construction Manager for corrections to deficiencies prior to proceeding.

3.02 PREPARATION

A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

3.03 INSTALLATION - GENERAL

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

D. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.

1. Resilient Strips: Attach to substrate using adhesive.

E. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

F. Install flooring in recessed floor access covers, maintaining floor pattern.

G. At movable partitions, install flooring under partitions without interrupting floor pattern.

3.04 INSTALLATION - SHEET FLOORING

A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.

B. Chemically bond seams using seam sealer where indicated.

C. Coved Base: Install as detailed on drawings, using coved base filler as backing at floor to wall junction. Extend sheet flooring vertically to height indicated, and cover top edge with metal cap strip.

3.05 INSTALLATION - TILE FLOORING

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

B. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.

C. Installation Method: See Material Finish/Color Schedule on the Drawings.

D. Install plank tile with a random offset of at least 6 inches (152 mm) from adjacent rows.

3.06 INSTALLATION - RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.

B. Install base on solid backing. Bond tightly to wall and floor surfaces.

C. Scribe and fit to door frames and other interruptions.

3.07 INSTALLATION - STAIR COVERINGS

A. Adhere over entire surface. Fit accurately and securely.

3.08 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's written instructions.

3.09 PROTECTION

A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 09 65 00

SECTION 09 68 13
CARPET FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Floor preparation as specified in Section 09 05 61 - Common Work Results for Flooring Preparation :
   1. Substrate Prep and Patching.
   2. Moisture Vapor Reduction Admixture (MVRA) in new slabs.
   3. Moisture Mitigation for Existing Slab on Grade.
B. Carpet tile, fully adhered.
C. Removal of existing carpet.
D. Resilient base.
   1. Base at freestanding or island casework.
E. Installation accessories.
F. Provide carpet in elevator cabs unless noted otherwise on the Drawings.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
C. Shop Drawings:
   1. Indicate color and pattern layouts.
   2. Provide FLOOR FINISH seaming diagrams.
D. Samples: Submit one carpet sample full size with manufacturer information attached, for each carpet specified.
E. Installer's Qualification Statement of Approval from the Manufacturer.
F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Provide 2% of each type/color of flooring, trim and base used on the project in original packaging.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in installing carpet tile with minimum five years documented experience and approved by carpet tile manufacturer.

1.04 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carpet: See Interior Material Finish/Color Schedule on the Drawings.

2.02 CARPET TILE MATERIALS

A. Carpet Tile: CPT-1, 2 and 3
   1. Manufacturer: See Interior Material Finish/Color Schedule on the Drawings.
   2. Tile Size: See Interior Material Finish/Color Schedule on the Drawings.
   3. Product/Collection/Pattern and Color: See Interior Material Finish/Color Schedule on the Drawings.

2.03 ACCESSORIES

A. Carpet Adhesive: As recommended by carpet manufacturer.
B. Moldings, Transition and Edge Strips:
   1. Refer to the requirements of Section 09 65 00 - Resilient Flooring.
   2. Manufacturers:
      a. Match resilient base manufacturer.

3. Transition/Reducer strips:
    a. Provide at all floor type transitions occurring at a door.
    b. Refer to accessories manufacturer for appropriate transition/reducer profile required for specified floor types.
    c. Color: See Interior Material Finish/Color Schedule, on the Drawings.

C. Resilient Base:

D. Refer to the requirements of Section 09 65 00 - Resilient Flooring.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.

C. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

D. Contact the General Contractor or Construction Manager for corrections to deficiencies prior to proceeding.

3.02 PREPARATION

A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install carpet in accordance with manufacturer's instructions.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile See Interior Material Finish/Color Schedule on the Drawings., with pile direction parallel to next unit, set parallel to building lines.

F. Locate change of color or pattern between rooms under door centerline.

G. Fully adhere carpet tile to substrate.

H. Trim carpet tile neatly at walls and around interruptions.

I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

3.05 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized representative to train Owner’s maintenance personnel on proper cleaning techniques and seam and carpet maintenance.

END OF SECTION 09 68 13

SECTION 09 72 00
WALL COVERINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall covering noted as VWC on the Drawings.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on wall covering and adhesive.
C. Shop Drawings: Indicate wall elevations with seaming layout.
D. Samples: Submit one sample of wall covering, 8 by 8 inch (203.2 by 203.2 mm) in size illustrating color, finish, and texture.
E. Test Reports: Indicate verification of flame and smoke ratings, when tested by UL.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. Extra Wall Covering Materials: Minimum 1 % or 10 linear feet (3.048 linear m) whichever is greater quantity of each color and pattern of wall covering; store where directed.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Inspect roll materials at arrival on site, to verify acceptability.
B. Protect packaged adhesive from temperature cycling and cold temperatures.
C. Do not store roll goods on end.

1.04 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.
B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
B. Chemical and Stain Resistance: No visible staining or discoloration and no damage to surface texture when tested in accordance with ASTM D1308.

2.02 WALL COVERINGS

A. Wall Covering: VWC#1 and 2: Roll stock.
    1. Comply with ASTM F793/F793M, Category V, Type II.
    2. Collection/Pattern/Color: See Interior Material Finish Schedule on the Drawings.
    3. Manufacturers: See Interior Material Finish/Color Schedule on the Drawings.
B. Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.
C. Termination Trim: See Interior Material Finish/Color Schedule on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are prime painted and ready to receive work, and comply with requirements of wall covering manufacturer.
B. Measure moisture content of surfaces using an electronic moisture meter. Do not apply wall coverings if moisture content of substrate exceeds level recommended by wall covering manufacturer.
C. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet (3 mm in 3 m) nor vary at a rate greater than 1/16 inch/ft (1.5 mm/300 mm).

3.02 PREPARATION

A. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.
B. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
C. Vacuum clean surfaces free of loose particles.

3.03 INSTALLATION

A. Apply adhesive and wall covering in accordance with manufacturer's instructions.
B. Apply adhesive to wall surface immediately prior to application of wall covering.
C. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.
D. Butt edges tightly.
E. Horizontal seams are not acceptable.
F. Do not seam within 2 inches (50 mm) of internal corners or within 6 inches (150 mm) of external corners.
G. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.
H. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.04 CLEANING

A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.
B. Reinstall wall plates and accessories removed prior to work of this section.

3.05 DEMONSTRATION AND TRAINING

A. Engage factory-authorized representative to train Owner’s personnel on wall covering cleaning techniques.

END OF SECTION 09 72 00

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.
B. Interior painting and coating systems.
C. Exterior painting and coating systems.
D. Scope:
    1. Finish surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
        a. Exterior:
            1) Concrete: Cementitious siding, Flexboard, Transite, non-roof shingles, common brick, stucco, tilt-up, precast, and poured-in-place cement.
            2) Masonry: Concrete masonry units (CMU), cinder or concrete block.
            3) Metal: Aluminum, galvanized.
            4) Metal, Miscellaneous: Iron, ornamental iron, structural iron and steel, ferrous metal.
            5) Wood: Siding, trim, shutters, sashes, and hardboard-bare/primed.
        b. Interior:
            1) Concrete, Walls and Ceilings: Poured concrete, precast concrete, unglazed brick, cement board, tilt-up, cast-in-place concrete, and plaster.
            2) Concrete Ceilings: Poured concrete, precast concrete, cement board, cast-in-place concrete, and plaster.
            3) Masonry (CMU: Concrete, split face, scored, smooth, high density, low density, and fluted.
            4) Metal: Aluminum.
            5) Metal, Galvanized: Ceilings and ductwork.
            6) Metal: Structural steel columns, joists, trusses, beams, miscellaneous and ornamental iron, structural iron, and ferrous metal.
            7) Wood: Walls, ceilings, and trim.
            8) Drywall: Walls, ceilings, gypsum board, and similar items.
            9) Cotton or Canvas pipe insulation.
            10) Field finishing of wood doors.
            11) Painting of interior and exterior surfaces of existing metal lockers, trim and sloped tops.
            12) Painted graphics and lettering as shown on drawings.
            13) Painting of plywood panels for technology equipment after the AHJ has verified that the proper fire-retardant plywood has been installed.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide complete list of products to be used, with the following information for each:
    1. Product characteristics.
    2. Surface preparation instructions and recommendations.
    3. Primer requirements and finish specification.
    4. Storage and handling requirements and recommendations.
    5. Application methods.
    6. Clean-up information.
C. Samples: Submit four paper draw down samples, 8-1/2 by 11 inches (216 by 279 mm) in size, illustrating range of colors available for each finishing product specified.
D. Maintenance Data: Submit coating maintenance manual including finish schedule showing where each product/color/finish was used, product technical data sheets, safety data sheets (SDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Paint and Finish Materials: Unused/previously opened cans of paint, but not less than 1 gallon (4 L) of each color; from the same product run, store where directed.
   2. Label each container with color in addition to manufacturer's label.

1.03 QUALITY ASSURANCE

A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 3 years experience and approved by manufacturer.
B. MPI Standards:
   1. Products: Complying with MPI standards indicated and listed in “MPI Approved Products List.”
   2. Preparation and Workmanship: Comply with requirements in “MPI Architectural Painting Specification Manual” for products and paint systems indicated.
   3. Previously Painted Surface Preparation and Workmanship: Comply with requirements in “MPI Maintenance and Repainting Manual” for products and paint system indicated.

1.04 EXAMINATION OF DOCUMENTS

A. Examine the specifications for the work of other trade contractors and to become familiar with their work. All surfaces that are left unfinished by the requirements of other specifications to be finished by this section.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
B. Container Label: Include manufacturer's name, type of paint, product name, product code, color designation, VOC content, batch date, environmental handling, surface preparation, application, and use instructions.
C. Paint Materials: Store at a minimum of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.
D. Handling: Maintain a clean, dry storage area to prevent contamination or damage to materials.

1.06 FIELD CONDITIONS

A. Do not apply materials when environmental conditions are outside the ranges required by manufacturer.
B. Follow manufacturer's recommended procedures for producing the best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
   1. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point; or to damp or wet surfaces.
   2. Do not apply coatings during cold, rainy or frosty weather.
   3. Do not apply to surfaces, which are exposed to hot sun.
C. The existing building may contain lead-containing materials, including paint. It is the Contractor's responsibility to meet all governmental regulations when dealing with and disposing of lead containing materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Products: Subject to compliance with requirements, provide products from one of the following manufacturers (all products are to be from the same manufacturer):
   1. Sherwin-Williams Company: Noted as "S-W"; www.sherwin-williams.com.
   2. PPG Paints: Noted as "PPG"; www.ppg.com.
   3. Benjamin Moore & Company: Noted as "BM"; www.benjaminmoore.com.

2.02 PAINTINGS AND COATINGS

A. General:
   1. Provide factory/paint store-mixed coatings unless otherwise indicated.
   2. Do not reduce, thin, or dilute coatings or add materials to coatings unless specifically indicated in manufacturer's instructions.

B. Volatile Organic Compound (VOC) Content:
1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
a. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site, or other method acceptable to authorities having jurisdiction.
1) Flat Paints & Coatings, VOC content of not more than 50 g/L.
2) Non-flat Paints & Coatings VOC content of not more than 150g/L.
3) Primers, Sealers, and Undercoaters VOC Content of not more than 100 g/L
4) Industrial Maintenance; to include Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
5) Floor Coatings: VOC not more than 100 g/L.
6) Shellacs, Clear: VOC not more than 730 g/L.
7) Shellacs, Pigmented: VOC not more than 550 g/L.
8) Stains, Interior: VOC not more than 250 g/L
9) Varnishes; VOC not more than 275 g/L

C. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

2.03 PAINT SYSTEMS - EXTERIOR

A. Concrete: Cementitious siding, Flexboard, Transite, non-roof shingles, common brick, concrete masonry units (CMU), stucco, tilt-up, precast, and poured-in-place cement.
1. Latex Systems:
a. Satin Finish:
1) 1st Coat:
(a) Sherwin-Williams Loxon Concrete and Masonry Primer Sealer LX02W50.
(b) PPG Perma-Crete Acrylic Alkali Resistant Primer 4-603.
(c) BM Fresh Start High hiding All Purpose Primer N046.
(1) Minimum 8 mils dry.
2) 1st Coat (Existing Surfaces):
(a) Sherwin-Willaims Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Stix Waterborne Bonding Primer SXA-110.
(1) Minimum 0.9 mils dry.

B. Metal: Aluminum.
1. Latex Systems:
a. Gloss Finish:
1) 1st Coat:
(a) S-W Pro Industrial DTM Acrylic Primer/Finish B66W00011.
(b) PPG Pitt-Tech Int/Ext Primer DTM, 90-712.
(c) BM Ultra Spec 500 Interior 0 VOC Latex Primer N534
(1) Minimum 2.5 mils dry.
2) 1st Coat (Existing Surfaces):
(a) Sherwin-Willaims Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Stix Waterborne Bonding Primer SXA-110.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coats:
(a) S-W Pro Industrial Acrylic Gloss, B66-600 Series.
(b) PPG Manor Hall Interior/Exterior Gloss Acrylic Latex, 52-110.
(c) BM Ultra Spec Exterior Gloss N449.
(1) Minimum 1.3 mils dry per coat.

C. Zinc Coated Metal: Flashing, Decking and Exposed Mechanical, including rooftop items.
    1. Latex Systems:
        a. Satin Finish:
            1) Touch-up:
                (a) S-W Pro Industrial DTM Acrylic Primer/Finish B66W00011.
                (b) PPG Pitt-Tech Int/Ext Primer DTM, 90-712.
                (c) BM Corotech Waterborne DTM Metal Primer/Finish V110.
                    (1) Minimum 2.5 mils dry.
            2) 2nd and 3rd Coats:
                (a) S-W A-100 Exterior Latex Satin A82-100 Series
                (b) PPG Speedhide Exterior Satin 6-2045XI.
                (c) BM Ultra Spec Exterior Satin N448.
                    (1) Minimum 1.3 mils dry per coat.

D. Zinc Coated Metal: Doors, Frames and Handrails.
    1. Gloss Finish:
        a. Touch-up:
            1) S-W Pro Industrial DTM Acrylic Primer/Finish B66W00011.
            2) PPG Pitt-Tech Int/Ext Primer DTM, 90-712.
            3) BM Corotech Waterborne DTM Metal Primer/Finish V110.
                (a) Minimum 2.5 mils dry.
        b. 2nd and 3rd Coats:
            1) S-W Pro Industrial Acrylic Gloss, B66-600 series
            2) PPG Manor Hall Interior/Exterior Gloss Acrylic Latex, 52-110.
            3) BM Ultra Spec Exterior Gloss N449.
            4) Minimum 1.3 mils dry per coat.

E. Wood: Painted hardboard-bare/primed, wood trim, plywood.
    1. Latex Systems:
        a. Satin Finish:
            1) 1st Coat:
                (a) S-W Exterior Latex Wood Primer B42W08141
                (b) PPG Speedhide Exterior Acrylic Wood Primer, 6-609.
                (c) BM Fresh Start High hiding All Purpose Primer N046.
                    (1) Minimum 1.8 mils dry.
            2) 1st Coat (Existing Surfaces):
                (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
                (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
                (c) BM Stix Waterborne Bonding Primer SXA-110.
                    (1) Minimum 0.9 mils dry.
            3) 2nd and 3rd Coat:
                (a) S-W A-100 Exterior Latex Satin A82-100 Series
                (b) PPG Speedhide Exterior Satin 6-2045XI.
                (c) BM Ultra Spec Exterior Satin N448.
                    (1) Minimum 1.3 mils dry per coat.

F. Wood: Semi-Transparent for Siding, Soffits, Fascia, Trim.
    1. Stain, Water Reducible Systems:
        a. Semi-Transparent:
            1) 1st and 2nd Coat:
                (a) S-W WoodScapes Exterior Polyurethane Semi-Transparent Stain, A15T00005.
                (b) BM Arborcoat Semi-Transparent Deck & Siding Stain 638.
                    (1) Rough/porous: 100-200 sq ft/gal (2.5 to 4.9 sg m/l)
                    (2) Smooth: 350 sq ft/gal (8.6 sq m/l)

G. Wood: Solid Color for Siding, Soffits, Fascia, Trim.
1. Stain, Water Reducible Systems:
a. Solid Color:
1) 1st and 2nd Coat:
(a) S-W WoodScapes Exterior Acrylic Solid Color Stain, A15 Series.
(b) PPG Flood SWF Exterior Solid Wood Stain.
(c) BM Arborcoat Solid Deck & Siding Stain 640.
(1) 200 to 400 sq ft/gal (4.9 to 9.8 sq m/L).

2.04 PAINT SYSTEMS - INTERIOR

A. Concrete: Poured concrete, precast concrete, unglazed brick, cement board, tilt-up, cast-in-place concrete.
1. Latex Systems:
a. Eg-Shel Finish (Walls):
1) 1st Coat:
(a) S-W Loxon Concrete and Masonry Primer Sealer, LX02W50 Series.
(b) PPG Perma-Crete Int/Ext Alkali Resistant Primer, 4-603.
(c) BM Super Spec High Building Masonry Primer N068.
(1) Minimum 3.0 mils dry.
2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Stix Waterborne Bonding Primer SXA-110.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coats:
(a) S-W ProMar 200 0 VOC Interior Latex Eg-Shel, B20-2600 Series.
(b) PPG Speedhide Interior Eggshell 6-4310XI.
(c) BM Ultra Spec 500 Interior Eggshell 538.
(1) Minimum DFT: 1.5 per coat.
b. Flat Finish (Ceilings)
1) 1st Coat:
(a) S-W Loxon Concrete and Masonry Primer Sealer, LX02W50 Series.
(b) PPG Perma-Crete Int/Ext Alkali Resistant Primer, 4-603.
(c) BM Super Spec High Building Masonry Primer N068.
(1) Minimum 3.0 mils dry.
2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Stix Waterborne Bonding Primer SXA-110.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coats:
(a) S-W ProMar 200 0 VOC Interior Latex, B30-2600 Series.
(b) PPG Speedhide Interior Flat 6-4110XI.
(c) BM Ultra Spec 500 Interior Flat 536.
(1) Minimum 1.4 mils dry per coat.
2. Epoxy Systems, Solvent Based:
a. Gloss Finish (Scheduled on Drawings to Receive Epoxy on Shower Walls):
1) 1st Coat:
(a) S-W Macropoxy 646-100 Polyamide Epoxy
(b) PPG Aquapon 35 Polyamide Epoxy Gloss, 95-1.
(c) BM Corotech Polyamide Epoxy Coating Gloss V400-62.
(1) Minimum 3.0 mils dry.

2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum, 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W Macropoxy 646-100 Polyamide Epoxy
(b) PPG Aquapon 35 Polyamide Epoxy Gloss, 95-1.
(c) BM Corotech Polyamide Epoxy Coating Gloss V400-62.
(1) Minimum, 2.0 mils per coat.

3. Epoxy Systems, Water Based:
a. Eg-Shel/Low Luster Finish, Scheduled on Drawings to Receive Epoxy (Walls):
1) 1st Coat:
(a) S-W Loxon Concrete and Masonry Primer Sealer, LX02W50 Series.
(b) PPG Perma-Crete Int/Ext Alkali Resistant Primer, 4-603.
(c) BM Super Spec High Building Masonry Primer N068.
(1) Minimum 3.0 mils dry.
2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum, 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W Water Based Catalyzed Epoxy Semi-Gloss B70 Series/B60V25
(b) S-W Pro Industrial WB Catalyzed Epoxy Eg-Shel or Gloss, B73-300 series
(c) PPG Pitt-Glaze WB. Epoxy Semi-Gloss, Series 16-551.
(d) BM Corotech Waterborne Amine Epoxy Gloss V440
b. Eg-Shel/Low Luster Finish-Single Component-Scheduled on Drawings to Receive Epoxy (Walls):
1) 1st Coat:
(a) S-W Multi Purpose Latex Primer / Sealer B51-450 Series
(b) PPG Seal Grip Int/Ext. Acrylic Universal Primer/Sealer, 17-921.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum, 1.5 mils.
2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum, 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy (Eg-Shell K45)
(b) PPG Pitt-Glaze WB1 Interior Pre-Catalyzed Waterborne Acrylic Epoxy
(c) BM Corotech High Performance Pre-Catalyzed Waterborne Epoxy Eggshell V342
(1) Minimum, 2.0 mils dry per coat.

B. Concrete (Contractor Option) New Ceilings: Poured concrete, precast concrete, cement board, cast-in-place concrete, and plaster.
1. Dryfall Waterborne Topcoats:
a. Eg-Shel Finish:
1) 1st and 2nd Coat:
(a) S-W Pro Industrial WB Acrylic Dryfall Eg-Shel, B42W00182

(b) PPG Speedhide Super Tech Flat-Eggshell 0-5 @60&85 Dry Fall, 6-725XI.
(c) BM Super Spec Sweep Up Flat Sheen 6@85, 153.
(1) Minimum 2.1 mils dry per coat.

C. Masonry (CMU): Concrete, split face, scored, smooth, high density, low density, and fluted.
1. Latex Systems:
a. Eg-Shel/Satin Finish:
1) 1st Coat:
(a) S-W Pro Industrial HD Block Filler, B42W00150.
(b) PPG Speedhide Int/Ext Masonry Block Filler, 6-7.
(c) BM Corotech Acrylic Block Filler V114.
(1) Minimum, 8.0 mils dry.
2) 1st Coat: (Contractor Option due to Schedule Constraints)
(a) S-W Loxon Concrete and Masonry Primer LX02W0050.
(b) PPG Perma-Crete Acrylic Alkali Resistant Primer 4-603.
(c) BM Fresh Start High hiding All Purpose Primer N046.
(1) Minimum 8.0 mils dry.
3) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Stix Waterborne Bonding Primer SXA-110.
(1) Minimum 0.9 mils dry.
4) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Eg-Shel, B20-2600 Series.
(a) Sherwin-Williams ProMar 200 Zero VOC Eg-Shel, B20-2600 Series.
(b) PPG Speedhide Interior Eggshell 6-4310XI.
(c) BM Ultra Spec 500 Interior Eggshell 538.
(1) Minimum 1.5 mils dry per coat.
2. Epoxy Systems, Solvent Based:
a. Gloss Finish (Scheduled on Drawings to Receive Epoxy in Showers):
1) 1st Coat:
(a) S-W Macropoxy 646-100 Polyamide Epoxy
(b) PPG Aquapon 35 Polyamide Epoxy Gloss, 95-1.
(c) BM Corotech Polyamide Epoxy Coating Gloss V400-62.
(1) Minimum 2.0 mils per coat.
2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W Macropoxy 646-100 Polyamide Epoxy
(b) PPG Aquapon 35 Polyamide Epoxy Gloss, 95-1.
(c) BM Corotech Polyamide Epoxy Coating Gloss V400-62.
(1) Minimum 2.0 mils per coat.
3. Epoxy systems, Water Based:
a. Eg-Shel/Low Luster Finish, Scheduled on Drawings to Receive Epoxy (Walls):
1) 1st Coat:
(a) S-W Pro Industrial HD Block Filler, B42W00150.
(b) PPG Speedhide Int/Ext Masonry Block Filler, 6-7.
(c) BM Corotech Acrylic Block Filler V114.
(1) Minimum 8.0 mils dry.

2) 1st Coat (Existing Surfaces):
   (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
   (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
   (c) BM Fresh Start High Hiding All Purpose Primer N046.
      (1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
   (a) S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy (Eg-Shell K45)
   (b) PPG Pitt-Glaze WB1 Interior Pre-Catalyzed Waterborne Acrylic Epoxy
   (c) BM Corotech High Performance Pre-Catalyzed Waterborne Epoxy Eggshell V342
      (1) Minimum 2.0 mils dry per coat.

b. Eg-Shel/Low Luster Finish-Single Component-Scheduled on Drawings to Receive Epoxy (Walls):
1) 1st Coat:
   (a) S-W Pro Industrial HD Block Filler, B42W00150.
   (b) PPG Speedhide Int/Ext Masonry Block Filler, 6-7.
   (c) BM Corotech Acrylic Block Filler V114.
      (1) Minimum 8.0 mils dry.
2) 1st Coat (Existing Surfaces):
   (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
   (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
   (c) BM Fresh Start High Hiding All Purpose Primer N046.
      (1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
   (a) S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy (Eg-Shell K45)
   (b) PPG Pitt-Glaze WB1 Interior Pre-Catalyzed Waterborne Acrylic Epoxy
   (c) BM Corotech High Performance Pre-Catalyzed Waterborne Epoxy Eggshell V342
   (d) Minimum 2.0 mils dry per coat.

D. Metal: Ferrous, Zinc Coated (not scheduled for epoxy, except for Showers). HM Doors and Frames, Handrails, Miscellaneous metals.
1. Alkyd Systems, Water Based - Electrostatic Painting of Existing Lockers
   a. Gloss Finish:
      1) 1st Coat:
         (a) S-W Kem Kromik Universal Metal Primer
         (b) PPG Speedhide Zinc Chromate Metal Primer, 6-204.
            (1) Minimum 1.5 mils dry.
      2) 2nd and 3rd Coats:
         (a) S-W P&M Industrial Alkyd Gloss Enamel, B54-100 Series
         (b) PPG Pitt-Tech Plus DTM Gloss, 90-912
            (1) Minimum 2.0 mils dry per coat.
2. Epoxy Systems, Water Based:
   a. Gloss Finish: Scheduled on Drawings for Epoxy on Shower Walls:
      1) Touch-up:
         (a) S-W Macropoxy 646-100 Polyamide Epoxy
         (b) PPG Aquapon 35 Polyamide Epoxy Gloss, 95-1.
         (c) BM Corotech Polyamide Epoxy Coating Gloss V400-62.
            (1) Minimum 2 mils dry.
      2) 2nd and 3rd Coat:
         (a) S-W Macropoxy 646-100 Polyamide Epoxy
         (b) PPG Aquapon 35 Polyamide Epoxy Gloss, 95-1.
         (c) BM Corotech Polyamide Epoxy Coating Gloss V400-62.
            (1) Minimum 2.0 mils per coat.

b. Semi-Gloss Finish:
1) Touch-up:
(a) S-W Pro Industrial DTM Acrylic Primer/Finish B66W00011.
(b) PPG Pitt-Tech Int/Ext Primer DTM, 90-712.
(c) BM Corotech Waterborne DTM Metal Primer/Finish V110.
(1) Minimum 2 mils dry.
2) 1st Coat: (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45/46-150 Series.
(b) PPG PITT-GLAZE WB1 Interior Semi-Gloss Pre-Catalyzed Water-Borne Acrylic Epoxy.
(c) BM Corotech WB Pre-Cat Epoxy Coating Semi-Gloss V341.
(d) Minimum 1.3 mils dry per coat.

E. Metal, Galvanized: Exposed Overhead, Ceilings and ductwork.
1. Dryfall Waterborne Topcoats:
a. Eg-Shel Finish:
1) Touch-up:
(a) S-W Pro Industrial DTM Acrylic Primer/Finish B66W00011.
(b) PPG Pitt-Tech Int/Ext Primer DTM, 90-712.
(c) BM Corotech Waterborne DTM Metal Primer/Finish V110.
(1) Minimum 2 mils dry.
2) 1st and 2nd Coat:
(a) S-W Pro Industrial Waterborne Acrylic Dryfall, B42-82 Series.
(b) PPG Speedhide Super Tech Flat-Eggshell 0-5 @60&85 Dry Fall, 6-725XI.
(c) BM Super Spec Sweep Up Flat Sheen 6@85, 153.
(d) Minimum 2.1 mils dry per coat.

F. Aluminum-Mill Finish:
1. Latex Systems:
a. Semi-Gloss High Performance:
1) 1st Coat:
(a) S-W Multi Purpose Latex Primer / Sealer B51-450 Series
(b) PPG Seal Grip Int/Ext. Acrylic Universal Primer/Sealer, 17-921.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 1.3 mils dry.
2) 1st Coat: (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W ProMar 200 0 VOC Interior Latex Eg-Shel, B20-2600 Series.
(b) PPG Speedhide Interior Eggshell 6-4310XI.
(c) BM Ultra Spec 500 Interior Eggshell 538.
(1) Minimum 1.3 mils dry per coat.

2. Epoxy Systems, Water Based:
    a. Gloss Finish-Scheduled on Drawings as Epoxy in Showers:
        1) 1st Coat:
            (a) S-W DTM Wash Primer B71Y1
            (b) PPG Multi Prime Epoxy Primer, 94-109.
            (c) BM Corotech Waterborne Bonding Primer V175.
                (1) Minimum 0.7 mils dry.
        2) 1st Coat (Existing Surfaces):
            (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
            (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
            (c) BM Fresh Start High Hiding All Purpose Primer N046.
                (1) Minimum 0.9 mils dry.
        3) 2nd and 3rd Coat:
            (a) S-W Macropoxy 646-100 Polyamide Epoxy
            (b) PPG Aquapon 35 Polyamide Epoxy Gloss, 95-1.
            (c) BM Corotech Polyamide Epoxy Coating Gloss V400-62.
                (1) Minimum 2.0 mils dry per coat.
    b. Eg-Shel/Low Luster Finish, Scheduled on Drawings to Receive Epoxy (Walls):
        1) 1st Coat:
            (a) S-W Multi Purpose Latex Primer / Sealer B51-450 Series
            (b) PPG Seal Grip Int/Ext. Acrylic Universal Primer/Sealer, 17-921.
            (c) BM Fresh Start High Hiding All Purpose Primer N046.
                (1) Minimum 1.3 mils dry.
        2) 1st Coat (Existing Surfaces):
            (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
            (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
            (c) BM Fresh Start High Hiding All Purpose Primer N046.
                (1) Minimum 0.9 mils dry.
        3) 2nd and 3rd Coat:
            (a) S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy (Eg-Shell K45)
            (b) PPG Pitt-Glaze WB1 Interior Pre-Catalyzed Waterborne Acrylic Epoxy
            (c) BM Corotech High Performance Pre-Catalyzed Waterborne Epoxy Eggshell V342
                (1) Minimum 2.0 mils dry per coat.
    c. Eg-Shel/Low Luster Finish-Single Component-Scheduled on Drawings to Receive Epoxy (Walls):
        1) 1st Coat:
            (a) S-W Multi Purpose Latex Primer / Sealer B51-450 Series
            (b) PPG Seal Grip Int/Ext. Acrylic Universal Primer/Sealer, 17-921.
            (c) BM Fresh Start High Hiding All Purpose Primer N046.
                (1) Minimum 1.3 mils dry.
        2) 1st Coat (Existing Surfaces):
            (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
            (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
            (c) BM Fresh Start High Hiding All Purpose Primer N046.
                (1) Minimum 0.9 mils dry.
        3) 2nd and 3rd Coat:
            (a) S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy (Eg-Shell K45)
            (b) PPG Pitt-Glaze WB1 Interior Pre-Catalyzed Waterborne Acrylic Epoxy
            (c) BM Corotech High Performance Pre-Catalyzed Waterborne Epoxy Eggshell V342
                (1) Minimum 2.0 mils dry per coat.

G. Wood:
1. Latex Systems (Painted- Walls, ceilings and trim):
a. Eg-Shel/Satin Finish:
1) 1st Coat:
(a) S-W Multi Purpose Latex Primer / Sealer B51-450 Series
(b) PPG Seal Grip Int/Ext. Acrylic Universal Primer/Sealer, 17-921.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 1.5 mils dry.
2) 2nd and 3rd Coat:
(a) S-W ProMar 200 0 VOC Interior Latex Eg-Shel, B20-2600 Series.
(b) PPG Speedhide Interior Eggshell 6-4310XI.
(c) BM Ultra Spec 500 Interior Eggshell 538.
(1) Minimum 1.3 mils dry per coat.
2. Stain and Varnish System (Wood-Transparent Finish):
a. Satin Finish:
1) 1st Coat:
(a) S-W Minwax Performance Series Tintable Wood Stain 250 VOC.
(b) PPG Deft Interior Oil Wood Stain.
(c) BM Lenmar QuickStain Alkyd Wiping Stain
(1) Spreading Rate: As needed to match architect's sample.
2) 2nd and 3rd Coat:
(a) S-W Minwax Polycrylic finish.
(b) PPG Deft Polyurethane Interior Satin.
(c) BM Benwood Stays Clear Polyurethane Satin N423.
(1) Minimum 1 mil dry per coat.

H. Drywall:
1. Latex Systems:
a. Eg-Shel Finish (Walls and similar items):
1) 1st Coat:
(a) S-W Multi Purpose Latex Primer / Sealer B51-450 Series
(b) PPG Seal Grip Int/Ext. Acrylic Universal Primer/Sealer, 17-921.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 1.5 mils dry.
2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W ProMar 200 Zero VOC Eg-Shel, B20-2600 Series.
(b) PPG Speedhide Interior Eggshell 6-4310XI.
(c) BM Ultra Spec 500 Interior Eggshell 538.
(1) Minumim 1.5 mils dry per coat.
b. Flat Finish (Soffits/Ceilings):
1) 1st Coat:
(a) S-W ProMar 200 Zero VOC Interior Latex Primer, B28W02600.
(b) PPG .SpeedHide Zero VOC Interior Latex Primer, 6-4900XI
(c) BM Ultra Spec 500 Interior 0 VOC Latex Primer N534
(1) Minimum 1.5 mils dry.

2) 1st Coat (Existing Surfaces):
   (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
   (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
   (c) BM Fresh Start High Hiding All Purpose Primer N046.
      (1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
   (a) S-W ProMar 200 0 VOC Interior Latex, B30-2600 Series.
   (b) PPG Speedhide Interior Flat 6-4110XI.
   (c) BM Ultra Spec 500 Interior Flat 536.
      (1) Minimu 1.4 mils dry per coat.

c. Flat primer: Surfaces Scheduled to Receive Vinyl Wallcovering, Wall Fabric or Tackable Wallcovering:
1) 1st Coat:
   (a) S-W Multi-Purpose Interior/Exterior Latex Primer B51W450.
   (b) PPG Seal Grip Acrylic Universal Primer, 17-921.
   (c) BM Fresh Start High Hiding All Purpose Primer N046.
      (1) Minimum 1.5 mils dry.
2) 1st Coat (Existing Surfaces):
   (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
   (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
   (c) BM Fresh Start High Hiding All Purpose Primer N046.
      (1) Minimum 0.9 mils dry.
3) 2nd Coat on Existing Surfaces:
   (a) S-W Multi-Purpose Interior/Exterior Latex Primer B51W450.
   (b) PPG Seal Grip Acrylic Universal Primer, 17-921.
   (c) BM Fresh Start High Hiding All Purpose Primer N046.
      (1) Minimum 1.5 mils dry per coat.

2. Epoxy Systems, Water Based:
a. Gloss Finish:
1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
   (a) 4 mils wet, 1.5 mils dry per coat.
2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Catalyzed Epoxy, B73-300 Series: www.sherwin-williams.com/#sle.
   (a) 5 mils wet, 2 mils dry per coat.

b. Semi-Gloss Finish-Two Component- Scheduled on Drawings to Receive Epoxy (Walls and similar items):
1) 1st Coat:
   (a) S-W Multi Purpose Latex Primer / Sealer B51-450 Series
   (b) PPG Seal Grip Int/Ext. Acrylic Universal Primer/Sealer, 17-921.
   (c) BM Fresh Start High Hiding All Purpose Primer N046.
      (1) Minimum 1.5 mils dry.
2) 1st Coat (Existing Surfaces):
   (a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
   (b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
   (c) BM Fresh Start High Hiding All Purpose Primer N046.
      (1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
   (a) S-W Water Based Catalyzed Epoxy B70 Series/B60V25 OR S-W Pro Industrial WB Catalyzed Epoxy Eg-Shel or Gloss, B73-300 series
   (b) PPG Pitt-Glaze WB. Epoxy Semi-Gloss, Series 16-551.

(c) BM Corotech Waterborne Amine Epoxy Gloss V440.
(1) Minimum 2.0 mils dry per coat.

c. Eg-Shel/Low Luster Finish-Single Component-Scheduled on Drawings to Receive Epoxy (Walls and similar items):
1) 1st Coat:
(a) S-W Multi Purpose Latex Primer / Sealer B51-450 Series
(b) PPG Seal Grip Int/Ext. Acrylic Universal Primer/Sealer, 17-921.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 1.5 mils dry.
2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy (Eg-Shell K45)
(b) PPG Pitt-Glaze WB1 Interior Pre-Catalyzed Waterborne Acrylic Epoxy
(c) BM Corotech High Performance Pre-Catalyzed Waterborne Epoxy Eggshell V342
(1) Minimum 2.0 mils dry per coat.
4) Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45 Series: www.sherwin-williams.com/#sle.

I. Cotton or Canvas Covering Over Insulation (except exposed overhead work):
1. Latex Systems:
a. Flat finish:
1) 1st Coat:
(a) S-W ProMar 200 Zero VOC Interior Latex Primer, B28W02600.
(b) PPG SpeedHide Zero VOC Interior Latex Primer, 6-4900XI
(c) BM Ultra Spec 500 Interior 0 VOC Latex Primer N534
(1) Minimum 1.5 mils dry.
2) 1st Coat (Existing Surfaces):
(a) S-W Extreme Bond Interior/Exterior Bonding Primer B51W001150
(b) PPG ACRI-SHIELD MAX Exterior Latex Bonding Primer.
(c) BM Fresh Start High Hiding All Purpose Primer N046.
(1) Minimum 0.9 mils dry.
3) 2nd and 3rd Coat:
(a) S-W ProMar 200 0 VOC Interior Latex, B30-2600 Series.
(b) PPG Speedhide Interior Flat 6-4110XI.
(c) BM Ultra Spec 500 Interior Flat 536.
(1) Minimum 1.4 mils dry per coat.

2.05 EXTRA STOCK

A. Provide left over paint with Owner for touch-up purposes. At completion of project, provide one complete set of drawdowns in each maintenance manual with a schedule noting the locations each paint color was used.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
C. Test shop-applied primer for compatibility with subsequent cover materials.
D. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

E. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent
   2. Masonry: 12 percent
   3. Wood: 15 percent
   4. Gypsum Board: 12 percent
   5. Plaster: 12 percent

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove mildew from impervious surfaces by scrubbing with solution of water and bleach. Rinse with clean water and allow surface to dry.

D. Formed and Precast Concrete:
   1. Remove release agents including form oil, curing compounds, dirt, laitance, loose cement, efflorescence, chalk and leftover residue from precast manufacturing process per paint manufacturer's recommendations.
   2. Fill bug holes, air pockets, and other voids with cement patching compound.
   3. Prepare concrete according to SSPC-SP 13.
   4. Previously painted surfaces must be free of grease, oil, wax or any other contaminants and loose or flaking paint. Clean concrete of oil and grease with detergent, hot water and vigorous scrubbing. All loose and peeling paint must be scraped or sand blasted back to sound adhesion.

E. Masonry: Remove efflorescence and chalk. After prime coat is dry, fill remaining small holes, cracks and other defects with Swedish putty made by mixing dry spackle with prime paint.
   1. Previously painted masonry surfaces must be dry, clean and free of dust, dirt and any other contaminants. Hard glossy surfaces are to be lightly sanded or dulled with deglosser/cleaner. Surfaces in poor condition must be prepared for repainting by removing loose paint and blisters by scraping, sanding or burning. Paint in these areas are to be removed at least 12 inches beyond the failing area. Patch all holes left after removal of nails, screws, and anchors. Prime before applying finish coats.

F. Cementitious Siding: Remove dirt, dust and other foreign matter. Pressure clean, if needed, to remove grease, oil, and loose particles.

G. Gypsum Board: Fill minor defects with filler compound; sand smooth and remove dust prior to painting.
   1. Previously painted gypsum wallboards must be completely dry, smooth-sanded, clean and free of dust, dirt, powdery residue, grease, oil, wax or any other contaminants such as flaking or peeling paint before paint application is started. Treat or remove all contaminants and correct defects. Dull glossy old paint by light sanding or with a commercial deglosser/cleaner to assure maximum adhesion of the new coating. Patch holes and cracks with a latex patching compound, sand smooth and spot prime with the paint or enamel to be used as the final coat.

H. Plaster: Fill hairline cracks, small holes, and imperfections with patching plaster. Make smooth and flush with adjacent surfaces. Treat textured, soft, porous, or powdery surfaces in accordance with manufacturer's instructions.
   1. Previously painted plaster surfaces must be dry, clean, and free of dust, dirt, powder residue, grease, oil, wax or any other contaminants; free of flaking, crumbling or chalking conditions before paint application is started. Contaminants must be treated or removed. Defects corrected as necessary. Dull glossy old paints by light sanding or with deglosser/cleaner to assure maximum adhesion of the new coating. Remove any loose, chipped, peeling or blistered old paint by scraping and smooth sanding. If highly porous old paint needs reconditioning before receiving the new application, prime the entire surface with undercoater oil primer. Patch holes and cracks with latex patching compound per manufacturer’s instructions after removing plaster as far back as necessary to reach firm areas. Spot prime patched areas with sealer-primer.

I. Aluminum: Remove surface contamination and oil; wash with solvent according to SSPC-SP 1.
   1. All chipped, peeling or blistered paint must be removed by hand or power tool cleaning. Remove all oil, grease, dirt or other foreign materials. Remove excessive chalking or sanding. Remove any mildew present by scrubbing with detergent and bleach. Thoroughly clean surface with water prior to repainting.

J. Galvanized Surfaces:
   1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
   2. Prepare surface according to SSPC-SP 2.
   3. Previously painted metal must be dry, clean and free of contaminants. Hard and glossy surfaces are to be sanded lightly or dulled with deglosser/cleaner. Remove peeling, loose, chipped, and blistered paint and rust by scraping and sanding. Prime all sanded areas and areas devoid of paint with an all-purpose metal primer.

K. Ferrous Metal:
   1. Solvent clean according to SSPC-SP 1.
   2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Prime bare steel surfaces.
   3. Remove rust, loose mill scale, and other foreign substances using methods recommended by paint manufacturer and blast cleaning according to SSPC-SP 6. Protect from corrosion until coated.
   4. Previously painted metal must be dry, clean and free of contaminants. Hard and glossy surfaces are to be sanded lightly or dulled with deglosser/cleaner. Remove peeling, loose, chipped, and blistered paint and rust by scraping and sanding. Prime all sanded areas and areas devoid of paint with an all-purpose metal primer.

L. Wood: Remove dust, grit, and foreign matter. Scrape, sand, and spot prime knots and pitch streaks. Fill nail holes and imperfections with wood filler and sand smooth.
   1. Previously painted surfaces must be free of dirt, mildew, loose paint, etc. Excessive chalking or dirt must be removed by washing with water. Hard glossy surfaces are to be lightly sanded or dulled with deglosser/cleaner. Openings permitting entrance of water should be caulked prior to painting. Surfaces in poor condition must be prepared for repainting by removing loose paint and blisters by scraping, sanding or burning. Paint in these areas is to be removed at least 12 inches beyond the failing area. Prime before applying finish coats.

3.03 SCHEDULE OF EXTERIOR WORK

A. General: Do not paint brick, stucco, precast concrete, prefinished aluminum, sealant (unless scheduled to receive paint).

B. New Work: Paint or finish all other new, unfinished, primed and factory painted surfaces, including all rooftop mechanical equipment, screen louvers, wall louvers (not factory-finished), miscellaneous metals, steel and galvanized steel lintels.

C. Existing Work: Prepare and paint all surfaces as noted on the drawings.

3.04 SCHEDULE OF INTERIOR WORK

A. General
   1. Paint complete all surfaces noted with a "PT" on Room Finish Schedule.
      a. New Work: In rooms with surfaces not scheduled for paint on Room Finish Schedule, paint hollow metal doors and frames, metal stairs and railings as occur.
      b. Existing Areas:
         1) Paint all items covered by notes on the drawings.
         2) Remodeling work: In rooms with surfaces scheduled for paint on Room Finish Schedule, paint hollow metal doors and frames, metal stairs and railings as occur.
         3) In unscheduled areas where patching has occurred, paint all walls corner to corner and floor to ceiling. Match adjacent wall color. Paint both sides of doors and frames at locations where replacement or modifications have been made.

c. Provide specified finish on exposed surfaces including, but not limited to the following:
    1) Prime coated mechanical units, piping, pipe covering, sprinkler piping, interior duct surfaces visible behind grilles, tanks without factory finish, radiation covers, cabinet unit heaters, exposed ductwork, louvers and grilles.
    2) Electrical panel box covers and surface raceways (over factory finish), conduits and boxes and all factory primed electrical equipment. (Except in maintenance, service and electrical rooms).
    3) Hollow metal doors and frames, steel stairs, ladders and railings, catwalks and safety mesh grilles, access panels, prime painted hardware, painted astragals and vision lite kits on doors, coiling grilles and doors (unless factory finished), metal supports for counters and exposed miscellaneous metals.
    4) Plywood backboards for electrical panels/devices and low voltage. Primer. Color white or to match adjacent wall surface, two coats on unistrut mounted backboards. Cover all sides and within cutout areas. Mask the fire-retardant rating stamp on each sheet prior to priming and painting. Leave the stamps exposed and visible.
d. Do not paint sealant.
e. DO NOT paint low voltage Category rated (Cat5, Cat6, Cat6A) cabling, as it voids the warranty.
f. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
g. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
h. Paint exposed ceiling areas visible around edges of "clouds".

3.05 APPLICATION

A. Conditions
    1. Do no work when surface, coating product, air temperature, humidity or dewpoint does not meet requirements of PROJECT CONDITIONS in Part 1 of this specification or manufacturers recommendations.
    2. Do no interior work until building is properly enclosed.
    3. Do work under adequate illumination and dust-free conditions.
B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
C. Apply products in accordance with manufacturer's written instructions.
D. Apply coatings at spread rate required to achieve manufacturer's recommended dry film thickness.
E. Regardless of number of coats specified, apply additional coats until complete hide is achieved.
F. Paint finish in food service areas to have an "orange peel" finish.

3.06 PRIMING

A. Apply primer to all surfaces unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.
    1. Tint prime and under coats being used under highly pigmented paint, approximately 1/2 to 3/4 depth of final color.
B. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to top coat manufacturers.

3.07 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
B. Clean surfaces immediately of overspray, splatter, and excess material.
C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

D. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.08 FIELD QUALITY CONTROL

A. Testing and Painting Application: Owner reserves the right to test DFT of painted surfaces.

B. If testing discovers that DFT of installed paint does not meet specification, the Contractor will pay for initial and final testing and recoat surfaces until testing agency confirms specification is met.

3.09 PROTECTION

A. Protect finished coatings from damage until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 90 00

SECTION 10 21 23
CUBICLE CURTAINS AND TRACK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended overhead curtain track and guides.
B. Surface mounted overhead curtain track and guides.
C. Cubicle curtains.

1.02 SUSTAINABILITY

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for curtain fabric characteristics and track, hanger and carriers.
C. Shop Drawings: Indicate a reflected ceiling plan view of curtain track, hangers and suspension points, attachment details, schedule of curtain sizes.
D. Samples: Submit one fabric samples, 12 by 12 inch (300 by 300 mm) in size illustrating fabric color.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept curtain materials on site and inspect for damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cubicle Track:
    1. Inpro: www.inprocorp.com/#sle.
    2. Equivalent products by other manufacturer's are acceptable.

2.02 TRACKS AND TRACK COMPONENTS

A. Tracks: Extruded aluminum sections; one piece per track run.
    1. Profile: Channel.
    2. Mounting:
    3. Structural Performance: Capable of supporting vertical test load of 50 lbs (23 kg) without visible deflection of track or damage to supports, safely supporting moving loads, and sufficiently rigid to resist visible deflection and without permanent set.
    4. Track End Stop: To fit track section.
    5. Track Bends: Minimum 12 inch (300 mm) radius; fabricated without deformation of track section or impeding movement of carriers.
    6. Suspension Rods: Tubular aluminum sections, sized to support design loads and designed to receive attachment from track and ceiling support.
        a. Escutcheons: Where suspension rod meets finished ceiling or structure, provide escutcheons to match rod finish.
    7. Finish on Exposed Surfaces: Clear anodized.
B. Curtain Carriers: Nylon rollers, size and type compatible with track; designed to eliminate bind when curtain is pulled; fitted to curtain to prevent accidental curtain removal.
C. Wand: Plastic, attached to lead carrier, for pull-to-close action.
D. Installation Accessories: Types required for specified mounting method and substrate conditions.

2.03 CURTAINS

A. Cubicle Curtains:
    1. Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
    2. Inherently flame resistant or flameproofed; capable of passing NFPA 701 test.
    3. Material: Close weave polyester; anti-bacterial, self deodorizing, sanitized, and preshrunk.
    4. Color/Pattern: See Interior Material Finish Schedule on Architectural Drawings.
    5. Open Mesh Cloth: Open weave to permit air circulation; flameproof material, manufacturer's standard color.
    6. Attachment of Curtain Fabric to Open Mesh Cloth: Manufacturer's standard sewn seam.

B. Curtain Fabrication:
   1. Width of curtain to be 10 percent wider than track length.
   2. Length of curtain to end 12 inches (305 mm) above finished floor.
   3. Include open mesh cloth at top 20 inches (508 mm) of curtain for room air circulation, attached to curtain as specified above.
   4. Curtain Heading: Fabric band matching curtain panel with metal grommet holes for carriers spaced 6 inches (150 mm) on center.
   5. Seams and Hems: Manufacturer's standard fabrication method for securely sewn and finished seams and hems.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and supports above ceiling are ready to receive work of this Section.
B. Verify that field measurements are as indicated on shop drawings.

3.02 INSTALLATION

A. Install curtain track to be secure, rigid, and true to ceiling line.
B. Secure track to ceiling system.
C. Install end cap and stop device.
D. Install curtains on carriers ensuring smooth operation.

END OF SECTION 10 21 23

SECTION 10 26 13
CORNER PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Corner guards noted as (CG-_) on the Drawings.
   1. Clear Plastic.
   2. Solid Color Plastic.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements , for submittal procedures.
B. Product Data: Indicate physical dimensions, anchorage details, and rough-in measurements.
C. Shop Drawings: Include plans, attachment details for locations, mounting heights of each type of product.
D. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
   1. Submit two sections of corner guards, 24 inches (610 mm) long.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
   1. Extra Stock Materials:
      a. One package(s) of minimum 96 inches (2438 mm) long unit of each kind of covers for corner guards.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver corner protection items in original, undamaged protective packaging. Label items to designate installation locations.
B. Protect work from moisture damage.
C. Protect work from UV light damage.
D. Do not deliver products to project site until areas for storage and installation are fully enclosed, and interior temperature and humidity are in compliance with manufacturer's recommendations for each type of item.
E. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

PART 2 PRODUCTS

1.01 MANUFACTURERS

A. Clear Plastic Corner Guards:
B. Solid Color Plastic Corner Guards with retainers:
   1. Inpro; Corner Guards: www.inprocorp.com.

1.02 PERFORMANCE CRITERIA

A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for compliance with applicable provisions of ASTM D256 and/or ASTM F476.
B. Chemical and Stain Resistance: Unless otherwise noted, provide protection products and assemblies with chemical and stain resistance complying with applicable provisions of ASTM D543.
C. Fungal Resistance: Unless otherwise noted, provide protection products and assemblies which pass ASTM G21 testing.

1.03 PRODUCT TYPES

A. Solid Color Plastic Corner Guards and End-Wall Protection: CG- and EW-
   1. Material: Polyethylene terephthalate (PET or PETG); PVC-free with full height extruded aluminum retainer.
      a. Surfaced mounted.
   2. Performance: Resist lateral impact force of 100 lbs (445 N) at any point without damage or permanent set.
   3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
   4. Width of Wings: 2 inches (51 mm).
   5. Corner: Radiused.
   6. Color/Finish: See Interior Material Finish/Color Schedule on the Drawings.
   7. Length: See Interior Material Finish/Color Schedule on the Drawings.
   8. Preformed end caps.

B. Clear Plastic Corner Guards - Surface Mounted, Transparent Plastic:
   1. Length: One piece, 48 inches (1219 mm).
C. Adhesives and Primers: As recommended by manufacturer.
D. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.
E. See Section 06 10 00 for wood blocking for wall and corner guard anchors.

1.04 FABRICATION

A. Pre-drill holes for attachment, if required.
B. Form end trim closure by capping and finishing smooth.

PART 3 EXECUTION

2.01 EXAMINATION

A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
B. Verify that field measurements are as indicated on drawings.
C. Verify that substrate surfaces for adhered items are clean and smooth.
   1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.
D. Start of installation constitutes acceptance of project conditions.

2.02 INSTALLATION

A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction and as indicated on shop drawings.

2.03 CLEANING

A. Clean corner protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION 10 26 13

SECTION 10 28 13
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Feminine hygiene vendors and disposals.
B. Grab bars.
C. Healthcare accessories.
D. Mirrors.
E. Shelves.
F. Shower and tub accessories.
G. Specialty accessories.
H. Toilet tissue dispensers.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordinate work to receive anchor attachments with the placement of:
   1. internal wall reinforcement with Section 09 21 16 Gypsum Wallboard Assemblies.
   2. concealed ceiling supports with Section 05 50 00 Miscellaneous Metals.
   3. wood blocking with Section 06 10 53 Rough Carpentry-Wood Blocking.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
   1. Provide a schedule indicating locations and quantities for each product being supplied or installed (for Owner provided items).
C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.04 WARRANTY

A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage or frame corrosion defects within specified warranty period.
   1. Warranty Period: 15 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer (unless noted otherwise): American Specialties, Inc: www.americanspecialties.com.
   1. Similar products by one of the following manufacturers are acceptable:
   2. Bobrick Washroom Equipment: www.bobrick.com.
   3. Bradley Corporation: www.bradleycorp.com.
   4. GAMCO, a Bobrick Company: www.gamcousa.com.
B. Basis of Design Manufacturer for Swing-up Grab Bar: GAMCO, a Bobrick Company: www.gamcousa.com.
C. Basis of Design for Shower Curtain Rods: Moen Incorporated: www.moen.com.

2.02 CUSTODIAL ACCESSORIES

A. Mop and Broom Holder (MH): 0.0375 inch (0.95 mm) thick stainless steel, Type 304, hat-shaped channel.
   1. Mounting: Surface.
   2. Holders: Cadmium-plated steel with spring-loaded rubber cam holders.
   3. Hooks: 14 gauge, 0.078 inch (1.98 mm) thick stainless steel rag hooks.
   4. Length: Manufacturer's standard length for number of holders.
   5. Products:
      a. ASI Model 1315-4 - Surface Mounted.

2.03 FEMININE HYGIENE VENDORS AND DISPOSALS

A. Sanitary Napkin Receptor Unit (SNR #_): Stainless steel, self-closing door, locking bottom panel with full-length heavy-duty stainless steel multi-staked piano hinge, removable receptacle.
   1. Mounting: As indicated in product listing.
   2. Cabinet and Door: Fully welded, 22 gauge, 0.03 inch (0.76 mm) thick sheet.
   3. Products:
      a. ASI Model 0852-SH - Sanitary Napkin Disposal with Shelf - Surface-mounted.
      b. Provide at staff and public toilets.

2.04 GRAB BARS

A. Grab Bars: Type 304 stainless steel.
   1. Standard Duty Grab Bars:
      a. Push/Pull Point Load: 250 lbf (1112 N), minimum.
      b. OD: 1-1/2 inch (38 mm).
      c. Tubing Thickness: 18 gauge, 0.05 inch (1.27 mm).
      d. Flange Mounting: Concealed fasteners.
      e. Clearance: 1-1/2 inch (38 mm) clearance between wall and inside of grab bar.
      f. Finish: Smooth on ends and peened in grip area.
      g. Length and Configuration: As indicated in product listing.
      h. Products:
         1) ASI Model 3800 - Snap Flange, 1-1/2 inch (38 mm) OD, Smooth.
            (a) GB # 1: 42 inch (1066.8 mm) horizontal and 18 inch (457.2 mm) vertical - used for toilet sidewall.
            (b) GB # 2: 36 inch (914.4 mm) - used for toilet backwall.
            (c) GB # 3: 18 inch (457.2 mm) - used for 36 x 36 shower - vertical sidewall.
            (d) GB # 5: two walled 16 x 31 inches (406.4 x 787.4 mm) - used for 36 x 36 shower - horizontal.
            (e) GB # 6: 36 inch (914.4 mm) sidewall and 48 inch (1219.2 mm) backwall - used for 36 x 60 shower - sidewall and back wall.
   2. Swing-up Grab Bars: Type 304 stainless steel and assembled into swivel hinge.
      a. Standard Duty Grab Bars:
         1) Push/Pull Point Load: 500 lbs (226.79 kg) downward, minimum.
         2) OD: 1-1/4 inch (32 mm).
         3) Tubing Thickness: As indicated on Technical Data Sheet for selected GAMKO model.
         4) Flange Mounting: As indicated in product listing. Minimum 4 1/4 inch (6.35 mm) diameter bolts provided by installer.
         5) Flange Thickness: 3/16 inch (4.76 mm).
         6) Finish: Smooth on ends and peened in grip area.
         7) Integral Toilet Paper Holder.
         8) Products:
            (a) GAMCO Model 125TPH.

2.05 MISCELLANEOUS ACCESSORIES

A. Retractable Clothes Line: Retractable reel with zinc-plated steel mounting bracket and stainless steel cover, 72 inch (1828.8 mm) vinyl covered cord.
   1. Products:
      a. ASI Model 0712 - Retractable Clothes Line - Surface-mounted.

2.06 MIRRORS

A. Mirrors (MIR #__): Stainless steel framed, 1/4 inch (6.35 mm) thick tempered safety glass, ASTM C1048.
   1. Size: As indicated on the drawings.
   2. Angle Frame: 0.04 inch (1.02 mm) angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.

3. Backing: Full-mirror sized, minimum 0.03 inch (0.76 mm) galvanized steel sheet and nonabsorptive filler material.
4. Products:
    a. ASI Model 0600 Series - Stainless Steel Inter-Lok Angle Frame - Plate Glass Mirror.

B. Custom Wood Framed Mirrors (MIR #__)
1. Refer to ACCESSORY/EQUIPMENT SCHEDULE on sheet A4.101.

2.07 SHOWER AND TUB ACCESSORIES

A. Shower Curtain Rod with Concealed Mounting (SCR): Stainless steel tube, 1 inch (25.4 mm) OD, 0.032 inch (0.81 mm) wall thickness, satin-finished, with 3 inch (76.2 mm) OD, minimum 0.04 inch (1.02 mm) thick satin-finished stainless steel flanges, for concealed mounting.
1. Products:
    a. ASI Model 1214-2 - Shower Curtain Rod - 1 inch (25.4 mm) OD Bar - Stainless Steel.
    b. ASI Model 1224 - Shower Curtain Rod End Flanges - One Pair.

B. Shower Curtain:
1. Material: Nylon reinforced vinyl, 0.008 inch (0.2 mm) thick, matte finish, with antibacterial treatment, flameproof and stain resistant.
2. Size: As required by drawings/application, hemmed edges.
3. Grommets: Stainless steel; pierced through top hem on 6 inch (152.4 mm) centers.
4. Color: White.
5. Shower Curtain Hooks: Chrome-plated or stainless steel spring wire designed for snap closure.
6. Products:
    a. ASI Model 1200-SHU - Shower Curtain Hook - Stainless Steel.
    b. For Splash Curtain in Spa, custom size constructed shower curtain mounted with retractable clothesline.

2.08 SOAP AND HAND SANITIZER DISPENSERS

A. Soap Dispenser (SD #__): Supplied by the Owner and installed by the Contractor.

B. Hand Sanitizer Dispenser: Supplied by the Owner and installed by the Contractor.

2.09 SPECIALTY ACCESSORIES

A. Towel Pin (TP): Single pin, concealed attachment.
1. Pin Material: As indicated in product listing.
2. Products:
    a. Model 7301-B - Towel Pin - Satin Stainless Steel - Surface-mounted.
    b. Provide one at each resident toilet room and other locations as noted on the drawings.

B. Towel Ring (TR): Post with hanging ring, concealed attachment.
1. Post and Ring Material: As indicated in product listing.
2. Products:
    a. Model 0785-Z - Towel Ring - Chrome Plated Zamak - Surface-mounted.
    b. Provide one at each resident toilet room and other locations as noted on the drawings.

C. Robe and Coat Hook (CH):
1. Mounting: As indicated in product listing.
2. Material and Finish: As indicated in product listing.
3. Products:
    a. Model 0745-Z - Robe Hook - Double - Chrome Plated Zamak - Surface-mounted.
    b. Provide one at each toilet room and office and where indicated on the drawings.

2.10 TOILET TISSUE DISPENSERS

A. Toilet Tissue Dispenser (TPH #__): Surface-mounted bracket type, stainless steel.
1. Capacity: 1800 sheet standard core roll.
2. Products:
    a. Model 7305-2S - Toilet Tissue Holder - Double- Satin Stainless Steel - Surface-mounted.

2.11 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
   1. Grind welded joints smooth.
   2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.
B. Keys: Provide 6 keys for each accessory to Owner.; master key lockable accessories.
C. Stainless Steel Sheet: ASTM A666, Type 304.
D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
F. Zinc Alloy: Die cast, ASTM B86.
G. Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.
H. Adhesive: Two component epoxy type, waterproof.
I. Fasteners, Screws, and Bolts: Hot dip galvanized; tamperproof; security type.
J. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.12 FINISHES

A. Stainless Steel: Satin finish, unless otherwise noted.
B. Chrome/Nickel Plating: ASTM B456, SC 2, polished finish, unless otherwise noted.
C. Baked Enamel: Pretreat to clean condition, apply one coat primer and minimum two coats epoxy baked enamel.
D. Powder-Coated Steel: Clean, degrease, and neutralize. Follow immediately with phosphatizing treatment, prime coat, and two finish coats of powder coat enamel.
E. Galvanizing for Items Other than Sheet: Comply with ASTM A123/A123M; galvanize ferrous metal and fastening devices.
F. Shop Primed Ferrous Metals: Pretreat and clean, spray apply one coat primer and bake.
G. Back paint components where contact is made with building finishes to prevent electrolysis.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify exact location of accessories for installation.
C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.
D. Verify that field measurements are as indicated on drawings.
E. Coordinate installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings with Section 06 10 53 and multiple studs at grab bars, wall mounted benches and baby changing stations with Section 09 21 16.

3.02 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.
B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
B. Mounting Heights: As required by accessibility regulations, unless otherwise indicated on t.

3.04 PROTECTION

A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 28 13

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire extinguishers noted as "FE" on the Drawings.
B. Fire blankets noted as "FB" on the Drawings.
C. Fire extinguisher cabinets and or brackets.
D. Accessories.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide extinguisher operational features and extinguisher ratings and classifications.
C. Shop Drawings: Indicate locations of cabinets and locations of individual fire extinquishers. Indicate types of fire extinguishers at each location.

1.03 FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguishers:
   1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com.
   2. Equivalent products by other manufacturers are acceptable.
B. Cabinets and Accessories:
   1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com.
   2. Equivalent products by other manufacturers are acceptable.

2.02 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
B. Refer to Fire Extinguisher Type / Mounting Schedule in Part 3 of this specification.
C. Multipurpose Dry Chemical Type Fire Extinguishers: Heavy duty steel cylinder with metal valve and siphon tube, O-ring seal, replaceable valve stem seal, visual pressure gage, pull pin and upright squeeze grip.
   1. Class: A:B:C type.
   2. Size: 10 pound (4.54 kg).
      a. Model: JL Industires Cosmic 10E, 4A-80BC
   3. Size and classification as scheduled be.
   4. Finish: Baked polyester powder coat, red color.
   5. Minimum Temperature: Minus 65 degrees F (Minus 54 degrees C).

2.03 FIRE EXTINGUISHER CABINETS

A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
B. Refer to Fire Extinguisher Type / Mounting Schedule in Part 3 of this specification.
C. Non Fire-Rated Cabinet Construction: Semi-Recessed.
   1. Formed aluminum with 3 inch (76.2 mm) rolled edge and continuous hinged door.
   2. Vertical narrow acrylic glazed door with lettering.
   3. Model for Multipurpose Dry Chemical Fire Extinguishers:
      a. JL Industries Academy 1029V10.
   4. Model for Wet Chemical Fire Extinguishers:
      a. JL Industries Academy 2029V10.
D. Fire Rated Cabinet Construction: Fire rating as indicated on Code Plans.
   1. Steel; outer and inner boxes fire barrier material.

2. Cabinet Configuration: Semi-recessed
    a. Formed aluminum with 2-1/2 inch (63.5 mm) or 3 inch (76.2 mm) rolled edge and continuous hinged door.
    b. Vertical narrow acrylic glazed door with lettering.
    c. Model for Multipurpose Dry Chemical Fire Extinguishers:
        1) JL Industries Academy 1027V10.
    d. Model for Wet Chemical Fire Extinguishers:
        1) JL Industries Academy 2027V10.

E. Door Glazing: Acrylic plastic, clear, 1/8 inch (3 mm) thick, flat shape and set in resilient channel glazing gasket.

F. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.

G. Finish of Cabinet Exterior Trim and Door: No.4 - Brushed stainless steel.

H. Finish of Cabinet Interior: Powder coated white.

2.04 ACCESSORIES

A. Fire Blanket/Cabinet: Fire retardant treated wool/synthetic, 62 by 80 inch (1574.8 by 2032 mm) x 2.75 pound (1.2474 kg) size.

B. Extinguisher Brackets: Formed steel, powder coated red with chrome strap.

C. Cabinet Lettering:
    1. Fire Extinguisher:“FIRE EXTINGUISHER” decal, or vinyl self-adhering, pre-spaced black lettering in accordance with authorities having jurisdiction (AHJ).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install cabinets plumb and level in wall openings, as noted on the drawings.

C. Secure rigidly in place.

D. Place extinguishers in cabinets and on wall brackets.

3.03 FIRE EXTINGUISHER TYPE / MOUNTING SCHEDULE

	APPLICATION	FIRE EXTINGUISHER TYPE/MOUNTING
A.	Public Occupied Space	Multipurpose Dry Chemical [10 lb] (4.54 kg) in Cabinet
B.	Non-public Occupied Space	Multipurpose Dry Chemical [5 lb] (2.27 kg) on Bracket

1. I.E., Boiler rooms and mechanical spaces, electrical and data rooms, receiving areas, storage rooms and elevator equipment rooms.

END OF SECTION 10 44 00

SECTION 12 24 00
WINDOW SHADES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior manual roller shades.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to provide rough-in of electrical wiring as required for installation of hardwired motorized shades.

B. Preinstallation Meeting: Convene prior to roughing in of electrical work related to products of this section; require attendance of affected installers.

C. Sequencing:
   1. Do not fabricate shades until field dimensions for each opening have been taken with field conditions in place.
   2. Do not install shades until final surface finishes and painting are complete.

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.

B. Shop Drawings: Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.

C. Selection Samples: Include fabric samples in full range of available colors and patterns.

D. Verification Samples: Minimum size 6 inches (150 mm) square, representing actual materials, color and pattern.

E. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of shop drawings.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.

B. Handle and store shades in accordance with manufacturer's recommendations.

1.05 WARRANTY

A. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:
   1. Manufacturer’s standard limited lifetime warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Interior Manually Operated Roller Shades:
   1. Draper, Inc; Clutch Operated FlexShade: www.draperinc.com.
   2. Hunter Douglas Architectural; RB500 Manual Roller Shades: www.hunterdouglasarchitectural.com.
   3. MechoShade Systems LLC; Mecho/7 System: www.mechoshade.com.
   4. SWFcontract, a division of Springs Window Fashions, LLC.; Pro Series Manual Solar Shade System: www.swfcontract.com.

2.02 ROLLER SHADES

A. General:
   1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
   2. Provide shade system that operates smoothly when shades are raised or lowered.

B. Roller Shades:
   1. Description - Interior Roller Shades: Single roller, manually operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories.
      a. Drop Position: Regular roll.
      b. Roll Direction: Bottom-up, closed position is at top of window opening.

c. Mounting: Window jamb mounted - inside, between jambs.
d. Size: As indicated on drawings.

2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
   a. Material: Stamped steel.
   b. Multiple Shade Operation: Provide hardware as necessary to operate more than one shade using a single motor.
3. Roller Tubes: As required for type of shade operation.
   a. Material: Extruded aluminum, galvanized steel or enameled steel.
   b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
   c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge or double-sided adhesive tape.
   d. Take-Up Roller: Manufacturer's standard roller tube pretensioned for winding lift cable in bottom-up type shades.
   e. Roller tubes to be capable of being removed and reinstalled without affecting roller shade limit adjustments.
4. Hembars: Designed to maintain bottom of shade straight and flat, selected from manufacturers standard options.
5. Accessories:
   a. Fascia: Extruded aluminum, size as required to conceal shade mounting, attachable to brackets without exposed fasteners; fabric wrapped finish to match shade.
      1) Profile: Square.
   b. End Caps for use with Fascia: Provide manufacturer's standard end caps to cover exposed ends of brackets.
   c. Blackout Shades:
      1) ShadesLight Gap Reduction Channels: Provide extruded aluminum channels to reduce light leakage at sides of shades.
      2) Provide a slot in bottom bar with wool-pile light seal.
      3) Interior Side Channels: As required for light sealing blackout shade applications.
   d. Ceiling Pockets: Premanufactured metal shade pocket for recess mounting shade hardware into ceiling. Provide removable closure panel to conceal underside of brackets and roller tubes.
   e. Ceiling Pockets with Prewired Raceway: UL 325 listed, extruded aluminum shade pocket with removable closure panel and ceiling tile support, for recess mounting in acoustical tile or drywall ceilings; size and configuration as indicated on drawings.
   f. Fasteners: Noncorrosive, and as recommended by shade manufacturer.

2.03 SHADE FABRIC

A. Fabric for Light-Filtering Shades: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
   1. Performance Requirements:
      a. Flammability: Pass NFPA 701 large and small tests.
      b. Fungal Resistance: No growth when tested according to ASTM G21.
   2. Manufacturer/Material/Openess/UV Blockage/Fabric Color: See Interior Material Finish/Color Schedule on the Drawings..
   3. Fabrication:
      a. Fabric Orientation: Railroaded, fabric is turned 90 degrees off the roll.
      b. If height of opening requires multiple panels of railroaded fabric, use battens at seams.
      c. Battens: Full width of shade, enclose in welded shade fabric pocket.

B. Fabric for blackout shades: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
    1. Performance Requirements:
        a. Flammability: Pass NFPA 701 large and small tests.
        b. Fungal Resistance: No growth when tested according to ASTM G21.
    2. Color: As selected by Architect from manufacturer's full range of colors.
    3. Color: See Interior Material Finish/Color Schedule on the Drawings.
    4. Fabrication:
        a. Fabric Orientation: Railroaded, fabric is turned 90 degrees off the roll.
        b. If height of opening requires multiple panels of railroaded fabric, use battens at seams.
        c. Battens: Full width of shade, enclose in welded shade fabric pocket.

2.04 ROLLER SHADE FABRICATION

A. Field measure finished openings prior to ordering or fabrication.
B. Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.
    1. Vertical Dimensions: Fill openings from head to sill with 1/2 inch (13 mm) space between bottom bar and window stool.
    2. Horizontal Dimensions - Outside Mounting: Cover window frames, trim, and casings completely.
C. At openings requiring continuous multiple shade units with separate rollers, locate roller joints at window mullion centers; butt rollers end-to-end.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine finished openings for deficiencies that may preclude satisfactory installation.
B. If substrate preparation is the responsibility of another installer, notify General Contractor or Construction Manager of unsatisfactory preparation before proceeding.
C. Start of installation shall be considered acceptance of substrates.

3.02 PREPARATION

A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
B. Coordinate with window installation and placement of concealed blocking to support shades.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
B. Replace shades that exceed specified dimensional tolerances at no extra cost to Owner.
C. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.04 CLEANING

A. Clean soiled shades and exposed components as recommended by manufacturer.
B. Replace shades that cannot be cleaned to "like new" condition.

3.05 PROTECTION

A. Protect installed products from subsequent construction operations.
B. Touch-up, repair, or replace damaged products before Substantial Completion.

END OF SECTION 12 24 00

SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Mechanical sleeve seals.
   3. Sleeves.
   4. Escutcheons.
   5. Grout.
   6. Fire-suppression equipment and piping demolition.
   7. Equipment installation requirements common to equipment sections.
   8. Painting and finishing.
   9. Concrete bases.
   10. Supports and anchorages.

1.02 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.03 SUBMITTALS

A. Product Data: For the following:
   1. Mechanical sleeve seals.
   2. Escutcheons.

B. Welding certificates.

1.04 CLOSEOUT

A. Record Documents: Prepare and submit record documents in accordance with the requirements in Division 1 Section "Project Record Documents." In addition to the requirements specified in Division 1, refer to specific sections for additional record documentation.

B. Maintenance Manuals: Prepare and submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data". Submit copies for review by Architect/Engineer. In addition to the requirements specified in Division 1, include the following information:
   1. Descriptive summary of function, normal system operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.
5. Warranty information for all mechanical items shall be included in one tabbed section.

1.05 QUALITY ASSURANCE

A. Product and Material Origin: All materials and products shall be manufactured within the 12 months of delivery to the site. Provide factory certified verification of the date of manufacture upon request form the Engineer.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

F. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.07 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.08 PRODUCT SUBSTITUTIONS

A. Equipment manufacturer’s where indicated on the drawings are the basis for design. The contractor accepts responsibility for all design implications when providing approved equipment other than the design basis.

B. Electrical Characteristics for Equipment: Equipment of higher electrical characteristics than the basis of design may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

C. Dimensional and Weight Changes: Equipment with dimensions or weight different than the basis of design may be furnished provided such proposed equipment is approved in writing. The contractor is responsible for verifying proposed equipment maintains the design intent for access and serviceability and reserves space for future equipment where required. Cost implications to other trades are the responsibility of the contractor.

1.09 INTERPRETATION OF PLANS

A. In general, the Drawings are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural Drawings which are dimensioned. Drawings shall not take precedence over field measurements.

B. Drawings are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail of construction. All work shall be constructed from field measurements taken at the site. This shall include all rises, drops and offsets necessary to avoid structural members or equipment and materials installed by other trades. The contractor shall coordinate the ductwork and piping layout before construction. No additional costs will be allowed for piping and ductwork fabrications without field verification of available space. If it is found, before installation, that a more convenient, suitable or workable arrangement of any or all phases of construction would result by altering the arrangement indicated on the Drawings, the architect/engineer may require the contractor to change the arrangement of his work without additional cost to the owner.

C. The drawings and specifications are intended to supplement each other. Any items shown on the drawings and not mentioned in the specifications, or vice versa, shall be executed the same as if mentioned and shown.

D. The greatest quantity or more expensive work shall govern where there is a conflict noted anywhere on the drawings and/or specifications.

1.10 COORDINATION DRAWINGS

A. Review contract documents and prepare coordination drawings as an informational submittal in accordance with Division 1 requirements. Provide drawings of all areas of the project to the Division 23 contractor. Participate in coordination meetings and revise drawings at the direction of the Division 23 contractor to resolve work conflicts. Conflicts between trades or existing conditions that arise due to work not being coordinated prior to installation shall be resolved at no cost to the Owner.

B. The Division 23 contractor will coordinate the preparation of drawings by other trades including steel, precast concrete, fire protection, lighting, plumbing, piping, and building sound systems. The Division 23 contractor will create composite drawings showing the work of all other trades. The Division 23 contractor will facilitate coordination meetings as scheduled and coordinated by the General Contractor or Construction Manger to review potential conflicts and propose specific solutions. Any proposed revisions to the Contract Documents shall be noted on the coordination drawings for review by the Architect and Engineer.

C. The composite drawings of all trades shall detail all structural building elements, mechanical equipment, and work of other trades. Indicate locations where space is limited for installation, access for service, and where sequencing and coordination of installations are of importance to the efficient flow of work. The composite drawings shall include at a minimum the following. Where required for clarity multiple composite drawings may have to be submitted for each area.

1. Clearances for installing and maintaining insulation.
2. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
3. Equipment connections and support details.
4. Exterior wall and foundation penetrations.
5. Fire-rated wall and floor penetrations.
6. Sizes and locations of required concrete pads and bases.
7. Valve stem movement.
8. Dimensional locations of pipe sleeves passing through floor/roof slabs.
9. Locations of wall and ceiling access panels where required for access to mechanical equipment.
10. Reflected ceiling plans to integrate installations of light fixtures, grilles, registers, and diffusers, sprinklers, communication systems, and other ceiling mounted components.
11. Both new and existing structural elements.

1.11 COST BREAKDOWN

A. Submit a cost breakdown for each claim according to General Conditions of the Contract. Include project name, location, Architect/Engineer, Contractor and date.

1. List the cost breakdown for labor and material separately and include a total.
2. Breakout and detail the cost according to specification sections.

1.12 FIRE SAFETY PRECAUTIONS

A. The Contractors shall exercise extreme care to maintain and exercise adequate fire safety precautions throughout the work. This shall include providing sufficient fire fighting devices, watchmen, standby helpers or other precautions during construction, in use of temporary heat, welding, brazing, sweating, testing or other phases of work.

B. At all times, access shall be maintained for fire department trucks to the building.

C. All welding brazing, cutting and sweating operations performed in vicinity of or accessible to combustible materials shall be adequately protected to make certain that sparks or hot slag does not reach the combustible material and start a fire.

D. All glass, glazed materials and other finish, in the vicinity of welding, brazing and cutting, shall be masked by the Contractor performing the welding work.

E. When necessary to do cutting, welding, brazing, sweating and similar work in vicinity of wood, in shafts, or vicinity of any combustible material (and the combustible material cannot be removed), the materials shall be adequately protected with fire resistant blankets or similar approved coverings. In addition, a helper shall be stationed nearby with proper fire extinguishers (provided by the Contractor performing the work) to guard against sparks and fire.

F. Whenever combustible materials have been exposed to sparks, molten metal, hot slag or splatter, a person shall be kept at the place of work to make sure the smoldering fires have not been started. Whenever cutting or welding operations are carried on in a vertical pipe shaft, a person to act as a fireguard shall be employed to examine all floors below the point of cutting or welding. This fireguard shall be kept on duty after completion of work to guard against fires and shall examine each level after this time, prior to leaving. There shall be no exceptions to this requirement and failure to comply will be construed as negligence.

1.13 PERSONAL SAFETY REQUIREMENTS

A. The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions required in connection with his work, including regulations of the Occupational Safety and Health Administration (OSHA) and other governing agencies.

1.14 PERMITS, LICENSES AND FEES

A. The Contractor shall secure all permits and licenses, both temporary and permanent required for their work. The Contractor shall pay all fees and expenses required for the permits and licenses.

1. The Contractor shall make all arrangements with each utility company and pay all service charges associated with new services or modifications to existing services.
2. The Contractor shall request inspections as required by regulating agencies and/or regulations. The Contractor shall pay all charges for inspections.
3. Contractor shall furnish the Owner with a certificate of final inspection and approval by enforcement authorities.
4. Comply with requirements of Division 00.

1.15 CORRECTIVE PERIOD / GUARANTEE

A. The Contractor shall guarantee and maintain the stability of work and materials and keep same in perfect repair and condition for the period of one (1) year after the Date of Substantial Completion of the Project.

B. Defects of any kind due to faulty work or materials appearing during the above mentioned period must be immediately made good by the Contractor at his own expense to the entire satisfaction of the Owner and Architect and Engineer Such reconstruction and repairs shall include damage to the finish or the building resulting from the original defect or repairs thereto.

C. The guarantee shall not apply to injuries occurring after final acceptance and due to wind, fire, violence, abuse or carelessness or other Contractors or their employees of the agents of the Owner.

D. This guarantee shall not apply where other guarantees for different lengths of time are specifically called for.

PART 2 PRODUCTS

2.01 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

2.02 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.04 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening. Provide brass material with polished chrome plated finish.

2.05 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 FIRE-SUPPRESSION DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, drain, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. Lead Containing Materials: The existing building may contain lead-containing materials, including lead paint. It is the Contractor’s responsibility to meet all governmental regulations when dealing with the disposing of lead containing materials.

E. Remove from building site debris, rubbish, fluids, and other materials resulting from demolition operations. Transport and legally dispose of offsite.
   1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
   2. Burning of removed materials is not permitted on project site.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install chrome plated brass escutcheons for penetrations of walls, ceilings, and floors that are not concealed above a ceiling.
M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. For piping penetrating gypsum-board partitions: Sleeves are not required for gypsum board penetrations unless required for fire rating.
      b. For all penetrations other than gypsum board partitions: Cast iron sleeves or Schedule 40 steel sleeves. Sleeves are not required for core drilled holes unless required for fire rating.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Flashing" for flashing.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Sealants and Caulking" for materials and installation.
N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Firestopping" for materials.
O. Verify final equipment locations for roughing-in.
P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.04 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.05 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.06 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 21 05 00

SECTION 21 10 00
WATER-BASED FIRE SUPPRESSION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section is to include the following fire suppression systems inside the building.
   1. Wet-pipe sprinkler systems.

1.02 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated and as required by NFPA and local authority having jurisdiction. The system shall include all piping, sprinklers, fittings, hangers, valves, flow switches, tamper switches, check valves, riser trim package(s), back-flow preventers, drains, inspector's test connections, fire department connections, gauges, signage and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. The new sprinkler system shall be tested and ready for full operation prior to substantial completion of the project.

1.03 PERFORMANCE REQUIREMENTS

A. Standard piping System Component Working Pressure: Listed for at least 175 psig.
B. Fire suppression sprinkler system design shall be approved by the authorities having jurisdiction.
   1. Margin of safety for available water flow and pressure: 5 psi, including losses through water-service piping, valves, and backflow preventers.
C. Refer to drawings for sprinkler occupancy hazard classification.

1.04 DELEGATED DESIGN SERVICES

A. The contractor shall provide design services to provide a system in accordance with the contract documents and referenced publications. Any conflicts between these documents shall be brought to the attention of the Engineer. The contractor is bidding the full scope of work in the drawings, specifications, and publications unless otherwise noted as an exclusion. The Owner shall not be charged additionally for work already contained within these contract documents. It remains the contractor's responsibility to read and understand the drawings, specifications, and referenced publications, and where questions persist, to resolve same before entering into the contract to perform this work. There shall be no extension of contract for work to be done as a part of this design package due to contractor's failure to implement the scope of work, plan the cost of such work, or the failure to verify field conditions.
B. Automatic sprinkler system designs shall include hydraulic calculations for the required hazard occupancy (light, ordinary, extra) with uniform water distribution over the design area. Each system shall include materials, accessories, and equipment, inside and outside the building, so that the system is complete and ready for use. Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts and other construction and equipment in accordance with detailed working drawings to be submitted for approval. Design system to eliminate use of pressure reducing valves (PRVs) through use of increased pipe sizes, looped branch lines, and/or multiple risers.
C. Contractor's designer shall be legally qualified to practice in jurisdiction where the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this project.

1.05 SUBMITTALS

A. Preliminary Shop Drawing: Upon substantial completion of the system layout and hydraulic calculations, submit reproducible drawings and hydraulic calculations to the Engineer for review prior to completing the final shop drawing. The Engineer will review the system layout and return a print marked to show changes required before the final shop drawing is made.

B. Final Shop Drawing: The final shop drawing shall be in accordance with the Authority Having Jurisdiction and shall include full size drawings of the complete piping and head layout indicating sprinkler zones, area hazard ratings, piping material, head types and method of hanging, hydraulic calculations must prove the remote area for each zone. Submit supplemental calculations for all non-typical areas. The final shop drawings must be stamped and signed by a Professional Engineer or individual with NICET level IV Certification.
   1. Submit final shop drawing to the reviewing agencies for approval. The reviewing authorities may include the following:
      a. State Fire Marshal
      b. City/Local Fire Marshal
      c. Health and Building Department
   2. Submit final shop drawing to the Owner's insurance carrier.
   3. Submit final shop drawing to the Engineer in electronic format. The shop drawing shall be stamped "approved" by each of the reviewing agencies. "Approved" copies submitted shall include the agencies reviewer comments.

1.06 CLOSEOUT DOCUMENTATION

A. Submit a statement certified by the design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

B. Record Documents: Submit record documents in accordance with the requirements in Division 1 Section "Project Record Documents."
   1. Submit as-built hydraulic calculations must be submitted to prove remote area criteria is met with all included field modifications.
   2. Submit Material Test Certificates for above and below ground piping.
   3. Submit drawings showing the system as installed including all deviations from both the project drawings and the approved shop drawings. The drawings shall also include all information as required by NFPA 13.

C. Maintenance Manuals: Submit maintenance data in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".

D. Provide building maps showing areas of the building that are covered by the fire suppression systems installed. Maps shall be laminated and permanently attached to the wall in the riser room. For renovated systems, it is the responsibility of the contractor to update and/or replace the existing maps. Maps shall include the following information.
   1. Areas served by each sprinkler zone. The sprinkler zone names and numbers shall match labels on the riser zone pipes.
   2. Location of Fire Department Connection.
   3. Location of Riser Rooms.
   4. Location of Inspector's test connections.
   5. Location of Knox box.

E. Submit field quality control reports.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Installation and alterations of fire protection piping, equipment, specialties, and accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified means experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope of this project), familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

B. Qualifications for Welding Processes and Operators: Comply with the requirements of AWS D10.9, "Specifications for Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3."

C. Regulatory Requirements: Comply with the requirements of the following codes:
   1. State Uniform Fire Code
   2. NFPA 13 – Standard for the Installation of Sprinkler Systems.
   3. UL and FM Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, and Factory Mutual approved for the application anticipated.
   4. International Building Code with State amendments.

1.08 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Do not interrupt sprinkler service to facilities occupied by Owner or others unless notifying the Owner, Construction Manager / General Contractor, Architect, and Engineer in advance and obtaining written approval.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and tat are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounting steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2: PRODUCTS

2.01 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of systems where the below specified pipe and fitting materials are used.

B. Ductile Iron Grooved-End Pipe with Mechanical Joints.
   1. Mechanical-Joint, Ductile-Iron Pipe: with mechanical-joint bell end and plain end.
      a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or grey-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      b. Glands, Gaskets, and Bolts: AWWA C111, ductile-or gray-iron gland, rubber gasket, and steel bolts and nuts.
   2. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.
      a. Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.
      b. Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, rubber gasket with center leg, and steel bolts and nuts.
      c. Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with end matching ductile-iron pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove rubber gasket listed for use with housing and steel bolts and nuts.

C. Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated.
   1. Threaded-end, factory or field-formed.
      a. Cast-Iron Threaded Flanges: ASME B16.1.
      b. Malleable-Iron Threaded Fittings: ASME B16.3.
      c. Gray-Iron Threaded Fittings: ASME B16.4.
      d. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
      e. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.

2. Plain-end:
    a. Steel Welding Fittings: ASTM A 234/A 234M, and ASM B16.9 or ASME B16.11.
    b. Steel Flanges and Flanged Fittings: ASME B16.5.
3. Grooved-end, factory or field form square-cut or roll formed.
    a. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
    b. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pie OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

D. Threadable Thinwall Steel Pipe:ASTM A135 or ASTM A795, hot-dip galvanized where indicated.
1. Threaded-end, factory or field-formed.
    a. Cast-Iron Threaded Flanges: ASME B16.1.
    b. Malleable-Iron Threaded Fittings: ASME B16.3.
    c. Gray-Iron Threaded Fittings: ASME B16.4.
    d. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
    e. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
2. Plain-end.
    a. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
    b. Steel Flanges and Flanged Fittings: ASME B16.5.
3. Grooved-end, factory or field form square-cut or roll formed.
    a. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
    b. Grooved-End –Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

E. Schedule 10 Steel Pipe: ASTM A135 or ASTM 795 in NPS 5 and smaller, and NFPA 13-specified wall thickness in NPS 6 to NPS 10. Hot-dip galvanized where indicated.
1. Plain-end.
    a. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
    b. Steel Flanges and Flanged Fittings: ASME B16.5.
2. Grooved-end, factory or field form square-cut or roll formed.
    a. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
    b. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting groves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

2.02 MECHANICAL OUTLET TEES

A. Tee Housing: Ductile iron conforming to ASTM A536 grade 65-45-12 with enamel coating. Tee housing shall extend around the entire pipe circumference. U-bolts are not acceptable.
B. Gaskets: Grade “E” EPDM for an operating temperature range -30°F to 230°F.
C. Bolts/Nuts: Heat treated plated carbon steel conforming to ASTM A-449 and ASTM A-183.

2.03 GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.04 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:
   1. Victaulic Co. of America
   2. Reliable Automatic Sprinkler Co., Inc.
   3. Viking Corp.
   4. Tyco
B. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig pressure rating if sprinklers are components of high-pressure piping system.
C. Automatic Sprinklers: With heat-responsive element complying with the following:
   1. UL 199, for nonresidential applications.
   2. UL 1767, for early-suppression, fast-response applications.
D. Sprinkler Types and Categories: Nominal ½-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
E. Sprinkler types, features, and options as follows: Provide quick response sprinklers.
   1. Concealed ceiling sprinklers, including cover plate.
   2. Pendent, dry-type sprinklers.
   3. Recessed sprinklers, including escutcheon.
   4. Sidewall sprinklers.
   5. Sidewall, dry-type sprinklers.
   6. Upright sprinklers.
F. Sprinkler Finishes: Chrome plated, bronze, and painted.
G. Special Coatings: Wax and corrosion-resistant paint.
H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, an d recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. The sprinkler head and guard assembly shall be UL listed.

2.05 FLEXIBLE SPRINKLER HOSE CONNECTION

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:
   1. Victaulic
B. The flexible sprinkler hose connection system with captured coupling shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
   1. The IGS Groove Style 108 coupling is single-bolt, consisting of two ductile iron housings, Grade E "EPDM" gasket, and a zinc electroplated steel bolt and nut conforming to ASTM A449.
C. The drop shall include a UL approved Series AH1, AH2, or AH2CC braided hose with a bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for; (4) bends at 31" length; (5) bends at 36" length; (8) bends at 48" length; (10) bends at 60" length; (12) bends at 72" length.

D. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 or AB2 bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed for sprinkler services to 175 psi (1206 kPa) and FM Approved to 200 psi (1380 kPa).
   1. All hoses shall be factory-pressure tested to 400 psi. (2760 kPa).
   2. AB6 Bracket Assembly, for use in cold storage applications with Victaulic Model V36 dry sprinklers.
   3. Approvals:
      a. FM-1637
      b. UL 2443

PART 3: EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article. Flow test data shall include test date, residual hydrant location, flow hydrant location, static pressure at residual hydrant, measured flow at flow hydrant, and residual pressure at residual hydrant.
B. Report test results promptly and in writing.
C. Provide delegated design services in accordance with Part 1 of this specifications section.

3.02 EARTHWORK

A. Refer to Division 31 Section "Trenching, Backfilling, and Compacting" for excavating, trenching, and backfilling.

3.03 EXAMINATION

A. Examine rough-in for fire equipment to verify actual locations of piping connections prior to installing.
B. Do not proceed until unsatisfactory conditions have been corrected.
C. Confirm valve interior to be free of foreign matter and corrosion.
D. Remove valve packing materials.
E. Examine valve guides and seats by operating valves from the fully open position to the fully closed position.
F. Examine valve threads and mating pipe for form and cleanliness.
G. Examine valve mating flange faces for conditions that might cause leakage.
   1. Check bolting for proper size, length, and material.
   2. Verify gasket for size, defects, damage, and suitable material composition for service.
   3. Replace all defective valves with new valves.

3.04 PIPE APPLICATIONS

A. Standard-pressure, wet pipe and sprinkler system, 175 psig maximum working pressure.
   1. Non-corrosive areas with exposed piping subject to abuse or vandalism.
      a. NPS 1 ½" and smaller: Schedule 40 with threaded, welded or grooved ends.
      b. NPS 2" and larger: Schedule 10 with welded or grooved ends.
   2. All other supervised or concealed areas.
      a. NPS 1 ½" and smaller: Threadable thin wall, with threaded, welded or grooved ends.
      b. NPS 2" and larger: Schedule 10, with welded or grooved ends.

3.05 PIPE JOINTS

A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in above ground applications, unless otherwise indicated.
B. Welded Joints: Provided welded joints where indicated on the drawings. Do not weld galvanized steel piping. Welding filler materials shall comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis.

C. Flanged Joints: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

D. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

E. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
   1. Ductile-Iron Pipe: Radius-cut grooved ends of piping, use grooved-end fittings and grooved-end-pipe couplings.
   2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
   3. Copper Tube: Roll-groove tubing. Use grooved-end fittings and grooved-end-tube couplings.

F. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with bolt piping materials.
   1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
   2. NPS 2 ½ to NPS 4: Use dielectric flanges.
   3. NPS 5 and Larger: Use dielectric flange insulation kit.

G. Mechanical Outlet Tees: May be used only at connections to existing pipe mains with approval of each instance from the mechanical engineer. Connections to branch piping is not acceptable. Mechanical outlet tees shall:
   1. Tee housing: Divide iron conforming to ASTM A536 grade 65-45-12 with enamel coating. Tee housing shall extend around the entire pipe circumference. U-Bolts are not acceptable.
   2. Gaskets: Grade “E” EPDM for an operating temperature range -30°F to 230°F.
   3. Bolts/Nuts: Heat treated plated carbon sheet conforming to ASTM A-449 and ASTM A-183.

3.06 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
      a. Shutoff Duty: Use ball, butterfly, or gate valves.
   2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 14.
      a. Shutoff Duty: Use ball, butterfly, or gate valves.
      b. Throttling Duty: Use ball or globe valves.

3.07 PIPING INSTALLATION

A. Refer to Division 21 Section “Common Work Results for Fire Suppression” for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

F. Install “Inspector’s Test Connections” in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install alarm devices in piping systems.
I. Hangers and Supports: Comply with NFPA 13 for hanger materials.
    1. Install standpipe system piping according to NFPA 14.
    2. Install sprinkler system piping according to NFPA 13.
J. Fill wet-pipe sprinkler system piping with water.

3.08 VALVE INSTALLATION

A. Installed listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA and authorities having jurisdiction.
B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
C. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.
D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
E. Specialty Valves:
    1. Double Detector Check Valves: Install for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.
F. Valves with threaded connections to have unions at equipment arranged for easy access, service, maintenance, and equipment removal without system shutdown.
G. Valves in horizontal piping installed with stem at or above the pipe center.
H. Position valves to allow full stem movement.

3.09 SPRINKLER APPLICATIONS

A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
    1. Rooms without Ceilings: Upright sprinklers.
    2. Rooms with Suspended Ceilings: Recessed sprinklers. Provide concealed sprinklers where ceiling heights are less than 7’-8” and where indicated on the Drawings.
    3. Wall Mounting: Sidewall sprinklers.
    4. Spaces Subject to Freezing: Pendent, dry sprinklers or sidewall, dry sprinklers.
    5. Sprinkler Finishes:
        a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view, rough bronze in unfinished spaces not exposed to view, wax coated where exposed to acids, chemicals or other corrosive fumes.
        b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
        c. Flush Sprinklers: Bright chrome, with painted white escutcheon.
        d. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
B. Provide sprinkler guards at all heads installed exposed in gyms and other similar spaces and when installed at heights 7’-0” or less and where indicated on the drawings.

3.10 SPRINKLER INSTALLATION

A. For suspended acoustical ceiling systems, align sprinklers as follows:
    1. 2’x4’ Ceiling Grid: Within 2” of the center or quarter points of the acoustical ceiling tile.
    2. 2’x2’ Ceiling Grid: Within 2” of the center of the acoustical ceiling tile.
B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.11 FLEXIBLE SPRINKLER HOSE CONNECTION INSTALLATION

A. Flexible sprinkler hose connection system may be provided where new lay-in suspended ceilings meeting ASTM C635 are indicated to be provided.
B. Install flexible sprinkler hose connection system per the manufacturer’s recommendation.

3.12 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
D. Electrical Connections: Power wiring is specified in Division 26. Fire alarm connections are specified in Division 28.
E. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”
F. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.13 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA.

3.14 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
    1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment
    3. Energize circuits to electrical equipment and devices.
    4. Start and run excess pressure pumps.
    5. Start and run air compressors.
    6. Flush, test, and inspect sprinkler systems according to NFPA 13, “Systems Acceptance” Chapter.
    7. Flush, test, and inspect standpipe systems according to NFPA 14, “System Acceptance” Chapter.
    8. Coordinate with fire alarm tests. Operate as required.
    9. Coordinate with fire-pump tests. Operate as required.
    10. Verify that equipment hose threads are same as local fire department equipment.
B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.15 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.
B. Remove and replace sprinklers with paint other than factory finish.
C. Protect sprinklers from damage until Substantial Completion.

3.16 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate and maintain the water-based fire suppression system. Refer to Division 01 Section “Demonstration and Training.”
    1. Required Time: As required.

END OF SECTION 21 10 00

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Pipe sleeves.
   4. Sleeves seals.
   5. Escutcheons.
   6. Grout.
   7. Plumbing demolition.
   8. Equipment and system installation common requirements.
   9. Painting.
   10. Concrete bases.
   11. Supports and anchorages.

1.02 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.03 SUBMITTALS

A. Welding certificates.

1.04 CLOSEOUT DOCUMENTATION

A. Record Documents: Prepare record documents in accordance with the requirements in Division 1 Section "Project Record Documents." In addition to the requirements specified in Division 1, refer to specific sections for additional record documentation.

B. Maintenance Manuals: Prepare maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data". Submit copies for review by Architect/Engineer. In addition to the requirements specified in Division 1, include the following information:
   1. Descriptive summary of function, normal system operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Warranty information for all mechanical items shall be included in one tabbed section.

1.05 QUALITY ASSURANCE

A. Product and Material Origin: All materials and products shall be manufactured within the 12 months of delivery to the site. Provide factory certified verification of the date of manufacture upon request form the Engineer.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. Lead Free Requirements: All plumbing pipes, fittings, valves, fixtures, and other components in systems providing water for human consumption shall be 'lead-free' in accordance with the "Reduction of Lead in Drinking Water Act" and the "Safe Drinking Water Act", where the term 'lead-free' is defined to mean – "not containing more than 0.2 percent lead when used with respect to solder and flux; and not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures."
1. Lead-free products shall be compliant with the requirements of either NSF 61-G or NSF 372.
2. Lead-free products shall bear a certified mark by a nationally accredited certification body.
3. Lead Free Requirements: All plumbing pipes, fittings

F. Pipe, pipe fittings, traps, fixtures, materials, and devices used in plumbing systems shall be listed (third-party certified) by a listing agency (accredited assessment body) as complying with approved applicable standards and shall be free from defects.

G. Each length of pipe and each pipe fitting, trap, fixture, material, and device used in a plumbing system shall have cast, stamped, or indelibly marked on it any marking required by the applicable referenced standards and listing agency, and the manufacturer's mark or name, which shall be readily identify the manufacturer to the end user of the product. Where required by the approved standard that applies, the product shall be marked with the weight and the quantity of the product. Materials and devices used or entering into the construction of plumbing and drainage systems, or parts thereof shall be marked and identified in a manner satisfactory to the Authority Having Jurisdiction. Such marking shall be done by the manufacturer. Field markings shall not be acceptable.

H. Prohibited Drainage Fittings: Double hub fitting, single or double tee branch, single or double tapped tee branch, side inlet quarter bend, running thread, band or saddle (except a double hub sanitary trapped tee used on a vertical line as a fixture connection).

I. Prohibited Drainage and Vent Piping: No drainage or vent piping shall be drilled and tapped for the purpose of making connections thereto, and no cast-iron soil pipe shall be threaded.

J. Freezing Protection: No water, soil, or waste pipe shall be installed or permitted outside of a building, in attics or crawl spaces, or in an exterior wall unless, where necessary, adequate provision is made to protect such pipe from freezing.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. Storage of materials and equipment shall not impede the work of other contracts.

D. Handling of equipment and products shall be according to manufacturers instructions and in compliance with the articles of their warranty.

E. Protect products from weather, unless product is slated for exterior installation. If outdoor storage is necessary, support products off the ground or pavement in watertight enclosures.

1.07 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for system installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for systems requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.08 PRODUCT SUBSTITUTIONS

A. Equipment manufacturer's where indicated on the drawings are the basis for design. The contractor accepts responsibility for all design implications when providing approved equipment other than the design basis.

B. Electrical Characteristics for Equipment: Equipment of higher electrical characteristics than the basis of design may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Required electrical modifications must be approved by the Electrical Engineer and be provided at no additional cost to the Owner. Required electrical modifications must be approved by the Electrical Engineer and be provided at no additional cost to the Owner. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

C. Dimensional and Weight Changes: Equipment with dimensions or weight different than the basis of design may be furnished provided such proposed equipment is approved in writing. The contractor is responsible for verifying proposed equipment maintains the design intent for access and serviceability and reserves space for future equipment where required. Cost implications to other trades are the responsibility of the contractor.

1.09 INTERPRETATION OF PLANS

A. In general, the Drawings are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural Drawings which are dimensioned. Drawings shall not take precedence over field measurements.

B. Drawings are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail of construction. All work shall be constructed from field measurements taken at the site. This shall include all rises, drops and offsets necessary to avoid structural members or equipment and materials installed by other trades. The contractor shall coordinate the ductwork and piping layout before construction. No additional costs will be allowed for piping and ductwork fabrications without field verification of available space. If it is found, before installation, that a more convenient, suitable or workable arrangement of any or all phases of construction would result by altering the arrangement indicated on the Drawings, the architect/engineer may require the contractor to change the arrangement of his work without additional cost to the owner.

C. The drawings and specifications are intended to supplement each other. Any items shown on the drawings and not mentioned in the specifications, or vice versa, shall be executed the same as if mentioned and shown.

D. The greatest quantity or more expensive work shall govern where there is a conflict noted anywhere on the drawings and/or specifications.

1.10 COORDINATION DRAWINGS

A. Review contract documents and prepare coordination drawings as an informational submittal in accordance with Division 1 requirements. Provide drawings of all areas of the project to the Division 23 contractor. Participate in coordination meetings and revise drawings at the direction of the Division 23 contractor to resolve work conflicts. Conflicts between trades or existing conditions that arise due to work not being coordinated prior to installation shall be resolved at no cost to the Owner.

B. The Division 23 contractor will coordinate the preparation of drawings by other trades including steel, precast concrete, fire protection, lighting, plumbing, piping, and building sound systems. The Division 23 contractor will create composite drawings showing the work of all other trades. The Division 23 contractor will facilitate coordination meetings as scheduled and coordinated by the General Contractor or Construction Manger to review potential conflicts and propose specific solutions. Any proposed revisions to the Contract Documents shall be noted on the coordination drawings for review by the Architect and Engineer.

C. The composite drawings of all trades shall detail all structural building elements, mechanical equipment, and work of other trades. Indicate locations where space is limited for installation, access for service, and where sequencing and coordination of installations are of importance to the efficient flow of work. The composite drawings shall include at a minimum the following. Where required for clarity multiple composite drawings may have to be submitted for each area.

1. Clearances for installing and maintaining insulation.
2. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
3. Equipment connections and support details.
4. Exterior wall and foundation penetrations.
5. Fire-rated wall and floor penetrations.
6. Sizes and locations of required concrete pads and bases.
7. Valve stem movement.
8. Dimensional locations of pipe sleeves passing through floor/roof slabs.
9. Locations of wall and ceiling access panels where required for access to mechanical equipment.
10. Reflected ceiling plans to integrate installations of light fixtures, grilles, registers, and diffusers, sprinklers, communication systems, and other ceiling mounted components.
11. Both new and existing structural elements.

1.11 COST BREAKDOWN

A. Submit a cost breakdown for each claim according to General Conditions of the Contract. Include project name, location, Architect/Engineer, Contractor and date.

1. List the cost breakdown for labor and material separately and include a total.
2. Breakout and detail the cost according to specification sections.

1.12 UTILITY REBATES

A. Prepare and submit utility rebate application forms and supporting documentation that are applicable within the scope of this project. Coordinate submittal with the project engineer and Owner's representative.

1.13 FIRE SAFETY PRECAUTIONS

A. The Contractors shall exercise extreme care to maintain and exercise adequate fire safety precautions throughout the work. This shall include providing sufficient fire fighting devices, watchmen, standby helpers or other precautions during construction, in use of temporary heat, welding, brazing, sweating, testing or other phases of work.

B. At all times, access shall be maintained for fire department trucks to the building.

C. All welding brazing, cutting and sweating operations performed in vicinity of or accessible to combustible materials shall be adequately protected to make certain that sparks or hot slag does not reach the combustible material and start a fire.

D. All glass, glazed materials and other finish, in the vicinity of welding, brazing and cutting, shall be masked by the Contractor performing the welding work.

E. When necessary to do cutting, welding, brazing, sweating and similar work in vicinity of wood, in shafts, or vicinity of any combustible material (and the combustible material cannot be removed), the materials shall be adequately protected with fire resistant blankets or similar approved coverings. In addition, a helper shall be stationed nearby with proper fire extinguishers (provided by the Contractor performing the work) to guard against sparks and fire.

F. Whenever combustible materials have been exposed to sparks, molten metal, hot slag or splatter, a person shall be kept at the place of work to make sure the smoldering fires have not been started. Whenever cutting or welding operations are carried on in a vertical pipe shaft, a person to act as a fireguard shall be employed to examine all floors below the point of cutting or welding. This fireguard shall be kept on duty after completion of work to guard against fires and shall examine each level after this time, prior to leaving. There shall be no exceptions to this requirement and failure to comply will be construed as negligence.

1.14 PERSONAL SAFETY REQUIREMENTS

A. The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions required in connection with his work, including regulations of the Occupational Safety and Health Administration (OSHA) and other governing agencies.

1.15 PERMITS, LICENSES AND FEES

A. The Contractor shall secure all permits and licenses, both temporary and permanent required for their work. The Contractor shall pay all fees and expenses required for the permits and licenses.
   1. The Contractor shall make all arrangements with each utility company and pay all service charges associated with new services or modifications to existing services.
   2. The Contractor shall request inspections as required by regulating agencies and/or regulations. The Contractor shall pay all charges for inspections.
   3. Contractor shall furnish the Owner with a certificate of final inspection and approval by enforcement authorities.
   4. Comply with requirements of Division 00.

1.16 CORRECTIVE PERIOD / GUARANTEE

A. The Contractor shall guarantee and maintain the stability of work and materials and keep same in perfect repair and condition for the period of one (1) year after the Date of Substantial Completion of the Project.

B. Defects of any kind due to faulty work or materials appearing during the above mentioned period must be immediately made good by the Contractor at his own expense to the entire satisfaction of the Owner and Architect and Engineer. Such reconstruction and repairs shall include damage to the finish or the building resulting from the original defect or repairs thereto.

C. The guarantee shall not apply to injuries occurring after final acceptance and due to wind, fire, violence, abuse or carelessness or other Contractors or their employees of the agents of the Owner.

D. This guarantee shall not apply where other guarantees for different lengths of time are specifically called for.

PART 2 PRODUCTS

2.01 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Plastic-to-Metal Transition Fittings: One-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

D. Plastic-to-Metal Transition Unions: MSS SP-107, four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.02 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.03 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.04 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.05 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening. Provide brass material with polished chrome plated finish.

2.06 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, drain, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. Lead Containing Materials: The existing building may contain lead-containing materials, including lead paint. It is the Contractor's responsibility to meet all governmental regulations when dealing with the disposing of lead containing materials.

E. Remove from building site debris, rubbish, fluids, and other materials resulting from demolition operations. Transport and legally dispose of offsite.
1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
2. Burning of removed materials is not permitted on project site.

3.02 EQUIPMENT AND SYSTEM INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Install transition fittings where necessary to accommodate installed materials of construction.

F. Install dielectric fittings at all metallic joints of dissimilar metal.

G. Install chrome plated brass escutcheons for penetrations of walls ceilings, and floors that are not concealed above a ceiling.

3.03 PIPE SLEEVE INSTALLATION

A. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
a. For pipes penetrating gypsum-board partitions: Schedule 40 steel pipe sleeves or steel sheet sleeves.
b. For all penetrations other than gypsum board partitions: Cast iron or schedule 40 steel sleeves.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Flashing" for flashing.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Sealants and Caulking" for materials and installation.

B. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

C. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Firestopping" for materials.

3.04 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.05 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section.

3.06 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.07 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.08 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

END OF SECTION 22 05 00

SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Iron ball valves.
   3. Bronze lift check valves.
   4. Bronze swing check valves.

1.02 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.03 SUBMITTALS

A. Provide product data for each type of valve indicated.

1.04 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.
C. NSF Compliance: NSF 61 for valve materials for potable-water service.
D. Lead Free Requirements: All plumbing pipes, fittings, valves, fixtures, and other components in systems providing water for human consumption shall be 'lead-free' in accordance with the "Reduction of Lead in Drinking Water Act" and the "Safe Drinking Water Act", where the term 'lead-free' is defined to mean – "not containing more than 0.2 percent lead when used with respect to solder and flux; and not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures."
   1. Lead-free products shall be compliant with the requirements of either NSF 61-G or NSF 372.
   2. Lead-free products shall bear a certified mark by a nationally accredited certification body.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
5. Motorized: Where noted on drawings.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

A. General:

1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.03 BRONZE LIFT CHECK VALVES

A. General:

1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125, Lift Check Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hammond Valve.
      b. Milwaukee Valve Company.
      c. NIBCO INC.
      d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 200 psig.
      c. Body Design: Vertical flow.
      d. Body Material: ASTM B 61 or ASTM B 62, bronze.
      e. Ends: Threaded.
      f. Disc: NBR, PTFE, or TFE.

2.04 BRONZE SWING CHECK VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.
B. Class 150, Bronze Swing Check Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.
      b. Milwaukee Valve Company.
      c. NIBCO INC.
   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 300 psig.
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded.
      f. Disc: Bronze.

2.05 IRON BALL VALVES

A. Class 125, Iron Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
      a. American Valve, Inc.
      b. Apollo Valves.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-72.
      b. CWP Rating: 200 psig.
      c. Body Design: Split body.
      d. Body Material: ASTM A 126, gray iron.
      e. Ends: Flanged.
      f. Seats: PTFE or TFE.
      g. Stem: Stainless steel.
      h. Ball: Stainless steel.
      i. Port: Full.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves.
2. Throttling Service: Ball valves.
3. Pump-Discharge Check Valves:
    a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded or solder ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint or threaded ends.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 to NPS 4:

1. Iron Valves: May be provided with threaded ends or flanged ends.
2. Iron Ball Valves: Class 125

C. Pipe NPS 5 and Larger:

1. Iron Valves: Provide with flanged ends.
2. Iron Ball Valves: Class 125.

END OF SECTION 22 05 23

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Pipe positioning systems.
   8. Equipment supports.

1.02 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.03 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.

D. Coordinate the work with other trades to provide additional framing and materials required for installation.

E. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

F. Coordinate the arrangement of supports with ductwork, piping, equipment, and other potential conflicts installed under other sections by others.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Powder-actuated fastener systems.
   4. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Pipe stands. Include Product Data for components.
   4. Equipment supports.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of Plumbing work.

B. Select hanger and supports materials and methods appropriate for the application in accordance with the most current edition of MSS SP-58.

C. Select support and attachment methods and components in accordance with manufacture's application criteria. Include considerations for vibration, equipment, operation, and shock loads where applicable. Notify the engineer for resolution where manufacturer requirements conflict with the requirements stated here-in. The more expensive materials and methods shall be included in the contractor's bid.

D. Steel components: Use corrosion resistant materials suitable for the environment where installed.
   1. Indoor Dry Locations: Zinc-plated steel unless otherwise indicated.
   2. Outdoor and Damp or Wet Indoor Locations: Galvanized steel, stainless steel, or approved equivalent.
   3. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   4. Galvanized Steel: Hot-dipped galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A152/A153M.

E. Dielectric barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type. Acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

2.02 TRAPEZE PIPE HANGERS

A. Description: Shop or field-fabricated support assembly made of continuous-slot metal strut channel with associated tracks, fittings, and related accessories. Provide in accordance with MSS SP-58 and NFMA-4 requirements.

2.03 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components. Provide in accordance with MSS SP-58 and NFMA-4 requirements.

B. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.04 INSULATION INSERT

A. Description: 100-psig minimum, compressive-strength insulation insert.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

D. For Trapeze or Clamped Systems: Insulation insert shall cover the entire point of contact with the pipe hanger or bracket.

E. For Clevis or Band Hangers: Insulation insert shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 INSULATION SHIELD

A. Description: 16 gauge galvanized sheet metal formed to fit contour of pipe insulation.

B. Shield Length: Minimum 12".

2.06 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.07 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   1. Base: Stainless steel.
   2. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   3. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   1. Bases: One or more plastic.
   2. Vertical Members: Two or more protective-coated-steel channels.
   3. Horizontal Member: Protective-coated-steel channel.
   4. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.08 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

2.09 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacture’s instructions.

B. Install anchors and fasteners in accordance with ICC evaluation services, ICC (ICC-es) evaluation report conditions of use where applicable.

C. Do not provide support from piping, ductwork, conduit, or other systems.

D. Do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval by the Structural Engineer.

G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

I. Secure fasteners according to manufacturer's recommended torque settings.

J. Remove temporary supports.

3.03 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use padded hangers for piping that is subject to scratching.
F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
    2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
    3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
    4. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
    5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
    6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
    7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
    8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
    9. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
    10. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
    11. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
    12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
    13. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
    14. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
    15. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
    2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
    2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
    3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
    4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
    5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
   10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
   11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
   12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb.
      b. Medium (MSS Type 32): 1500 lb.
      c. Heavy (MSS Type 33): 3000 lb.
   13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
   14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
   15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

N. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.04 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Insulation Insert Installation: Install in pipe hanger for all insulated piping 2” and larger.

E. Insulation Shield: Install insulation shields (in addition to the insulation insert where it is required) at all hanger locations for insulated piping.

F. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

H. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above or below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      b. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
   2. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.

c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

3. Pipes NPS 8 and Larger: Include wood inserts.
4. Insert Material: Length at least as long as protective shield.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.05 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.06 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.07 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to a maximum of 1-1/2 inches. Threaded rods shall be trimmed to be flush with supports in exposed areas at 7’-0” and lower.

3.08 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 22 05 29

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Valve tags.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Provide a listing of all equipment to be labeled with the proposed content for each label.

1.03 CLOSEOUT DOCUMENTATION

A. Record Documents: Submit record documents in accordance with the requirements in Division 1 Section "Project Record Documents."
   1. Provide as-built drawing showing all valves and corresponding valve number.
   2. Provide valve schedule.

1.04 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch or stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   4. Fasteners: Stainless-steel, rivets or self-tapping screws.
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
C. Label Content: Include equipment's Drawing designation or unique equipment number.
D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.03 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link, beaded chain, or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Provide equipment labels for each piece of equipment identified on the drawing schedule.

3.03 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section “Painting.”

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Non-Potable Water Systems:

1. Labeled with the words “CAUTION: NON-POTABLEWATER, DO NOT DRINK.”
2. Identify the liquid being conveyed, and the direction of normal flow.
3. Locate labels every 20 feet but not less than once per room.
4. Labels shall be visible from the floor level.

D. Pipe Label Color Schedule:
   1. Potable Water:
      a. Background Color: Green.
      b. Letter Color: White.
   2. Non-Potable Water:
      a. Background Color: Yellow.
      b. Letter Color: Black.
   3. Sanitary Waste and Storm Drainage Piping:
      a. Background Color: Green.
      b. Letter Color: White.

3.04 VALVE-TAG INSTALLATION

A. Install tags on main and branch line shut off valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves at equipment; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Cold Water: 1-1/2 inches, round.
      b. Hot Water: 1-1/2 inches, round.
   2. Valve-Tag Color:
      a. Cold Water: Natural.
      b. Hot Water: Natural.
   3. Letter Color:
      a. Cold Water: Black.
      b. Hot Water: Black.

END OF SECTION 22 05 53

SECTION 22 07 00
PLUMBING INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Insulation Materials:
   2. Jacketing and accessories.
   3. Weather barrier coatings.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any). Provide shop drawings detailing application of protective shields; saddles; inserts; covering of heat tracing; application at pipe expansion joints; application elbows, fittings, flanges, valves, and specialties; removable insulation at specialties, equipment connections, and access panels; application of field-applied jackets; application at linkages of control devices; and field application for each equipment type.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in applying insulation materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance. Installer shall meet, at a minimum, all requirements listed below. Upon request, submit evidence of such qualifications to the Architect.
   1. Company specializing in performing work of this section with minimum three years documented experience, minimum three successfully completed projects of similar scope and complexity, and approved by manufacturer.
   2. Designate one individual as project foreman who shall be on site at all times during installation.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.05 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.06 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric (FE): Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials; thermal conductivity (avg) of 0.27 Btu/hr-ft2-□F or lower at mean temperature of 75□F; 3.0 lbs./ft3 density (ASTM D/622); 0.08 perm-in permeability (ASTM E96); 0.2% water absorption (ASTM C209).

G. Mineral-Fiber Blanket Insulation (MF): Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I; thermal conductivity (avg) of 0.25 Btu/hr-ft2-□F or lower at mean temperature of 75□F. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber, Preformed Pipe Insulation (MF): Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL; thermal conductivity (avg) of 0.25 Btu/hr-ft2-□F or lower at mean temperature of 75□F. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

I. Mineral-Fiber, Pipe and Tank Insulation (MF): Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 3.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.
4. Color: White.

2.05 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
   2. Service Temperature Range: Minus 50 to plus 180 deg F.
   3. Color: White.

2.06 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: White.

2.07 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I, for applications where systems operate below ambient temperature at least part of the time or where a vapor barrier is required.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I, for applications where systems operate below ambient temperature at least part of the time or where a vapor barrier is required.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II, for applications where systems operate above ambient temperatures or where a vapor retarder is not required.

2.08 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, as follows:
   1. Shall comply with ASTM C921, Type I, for applications where systems operate below ambient temperature at least part of the time or where a vapor barrier is required.
   2. Shall comply with ASTM C921, Type II, for applications where systems operate above ambient temperatures or where a vapor retarder is not required.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: White.
   3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   4. Factory-fabricated tank heads and tank side panels.

C. Fitting Covers:
   1. PVC Jacket: One or two piece pre-molded high impact PVC fitting covers with fiberglass inserts and accessories. Covers shall be UV resistant and comply with ASTM 1784-92. Covers shall be sized to comply with insulation applications detailed in Part 3.0.
      a. Below ambient systems: provide continuous vapor barrier in accordance with manufacturer recommendations.
      b. Fiberglass Inserts: Thermal conductivity (ASTM C177), thermal conductivity average of 0.26 Btu/hr-ft2-˚F or lower at a mean temperature of 75 ˚F.

2.09 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches.
   2. Thickness: 3.7 mils.
   3. Adhesion: 100 ounces force/inch in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:
   1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 0.015 inch thick, 1/2 inch wide with wing seal.
   2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Insulation Pins and Hangers:
   1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
   2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
    c. Adhesive-backed base with a peel-off protective cover.
5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.03 PIPING INSULATION APPLICATION

A. Indoor Piping System Insulation: Insulate with insulation types and thickness as listed in Table below. If more than one pipe material is listed for a piping system, selection from materials listed is the contractor's option.
1. Potable cold water, hot water, and hot water circulating piping.
2. Interior aboveground, horizontal and vertical storm water piping. Storm water piping includes all piping connected to both primary and overflow roof drains including drain bodies.
3. Plumbing vents within 6 lineal feet of roof outlet.
4. Condensate drain piping from cooling coils.
5. Make-up water piping to HVAC equipment and systems.

6. P-trap and 25 lineal feet of sanitary piping from AHU condensate drains.

TABLE NO. 22 07 00-1: MINIMUM PIPE INSULATION

Piping System (2)	Fluid Temp Range °F	Type of Insulation (1)	¾" and Smaller	1" to 1 ¼"	1 ½" to 3"	4" and Larger
CW Piping	40-60	MF, FE	½"	½"	1"	1"
HW Piping	105-140	MF	1"	1"	1 ½"	1 ½"
CHW Piping	105-140	MF	1"	1"	1 ½"	1 ½"
HW Piping (3)	141-200	MF	1 ½"	1 ½"	2"	2"
CHW Piping (3)	141-200	MF	1 ½"	1 ½"	2"	2"
Storm Drains	Any	MF, FE	-	-	1"	1"
Plumbing Vents	Any	MF, FE	-	-	1"	1"
Hot Drain Piping	Any	MF	½"	½"	1"	1"
P-Trap and Sanitary	Any	MF, FE	½"	½"	1"	1"

NOTES:

7. Insulation material abbreviations:
   a. Mineral Fiber (MF) – with factory jacket per 2.0 requirements.
   b. Flexible Elastomeric (FE)
8. Piping Service abbreviations:
   a. Cold Water (CW)
   b. Hot Water (HW)
   c. Circulating Hot Water (CHW)
9. Insulation thickness for piping smaller than 1½" may be reduced to 1" for piping located in partitions within conditioned spaces.

B. Refer to Division 22 Section 22 05 29 "Hangers and Supports for Piping and Equipment" for insulation insert and insulation shield requirements.

C. Insulation Omitted: Omit insulation for the following:
   1. Interior air conditioner condensate drain piping in mechanical rooms provided piping is less than 3 lineal feet and is located within 12" of floor.
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
   3. Discharge piping from trap primer valves connected to building sanitary waste floor drain traps.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. For all insulation, seal exposed fiberglass including cut pre-formed pipe sections with manufacturer's approved mastic.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.05 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Firestopping."

3.06 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Fiberglass inserts with PVC fitting covers are acceptable. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Fiberglass inserts with PVC fitting covers are acceptable. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Fiberglass inserts with PVC fitting covers are acceptable. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Fiberglass inserts with PVC fitting covers are acceptable. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Provide 16 gauge galvanized sheet metal insulation shields at all hanger locations. Shields shall be a minimum 12" in length and formed to fit pipe contour.

3.07 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.09 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

END OF SECTION 22 07 00

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Encasement for piping.
   3. Specialty valves.
   4. Flexible connectors.
   5. Escutcheons.
   6. Wall penetration systems.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated.

1.03 CLOSEOUT DOCUMENTATION

A. Record Documents: Submit record documents in accordance with the requirements in Division 1 Section "Project Record Documents."
B. Maintenance Manuals: Submit maintenance data in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data". Submit copies for review by Architect/Engineer.
C. Field quality control reports.
D. Cleaning and disinfecting reports.

1.04 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 61 for potable domestic water piping and components.
C. Lead Free Requirements: All plumbing pipes, fittings, valves, fixtures, and other components in systems providing water for human consumption shall be 'lead-free' in accordance with the "Reduction of Lead in Drinking Water Act" and the "Safe Drinking Water Act", where the term 'lead-free' is defined to mean – "not containing more than 0.2 percent lead when used with respect to solder and flux; and not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures."
   1. Lead-free products shall be compliant with the requirements of either NSF 61-G or NSF 372.
   2. Lead-free products shall bear a certified mark by a nationally accredited certification body.

1.05 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of water service.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
   1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
B. Copper Pressure-Seal-Joint Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
      a. Viega.

2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

C. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper. Copper Solder-Joint Fittings complying with ASME B16.22, wrought-copper pressure fittings.

2.03 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.04 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.05 TRANSITION FITTINGS

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

D. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions: CPVC four-part union. Include brass threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.06 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions: 150 psig at 180 degrees F., solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges: Factory-fabricated, bolted, companion-flange assembly. Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits: 150 psig rated, non-conducting materials for field assembly.
1. Gasket: Neoprene or phenolic.
2. Bolt Sleeves: Phenolic or polyethylene.
3. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings: 300 psig at 225 degrees F., galvanized steel coupling.
1. End Connections: Female threaded.
2. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples: ASTM F1545, 300 psig at 225 degrees F., electroplated steel nipple.
1. End Connections: Male threaded.
2. Lining: Inert and noncorrosive, propylene.

2.07 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

E. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

F. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.08 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

A. Above Ground:
    1. Pipes Tagged 2" or Smaller:
        a. Type L, drawn copper tube with wrought copper fittings and solder joints.
        b. Type L, drawn copper tube with pressure-seal fittings and joints.
        c. PEX-a tubing and cold expansion fittings with PEX-a reinforcing rings.
    2. Pipes Tagged 2 ½" to 4"
        a. Type L, drawn copper tube with wrought copper fittings and solder joints.
        b. Type L, drawn copper tube with pressure-seal fittings and joints.
    3. Pipes Tagged 5" or Larger:
        a. Type L, drawn copper tube with brazed joints.
B. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
C. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

3.02 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    1. Apply appropriate tape or thread compound to external pipe threads.
    2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
H. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

3.03 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
    2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
    3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
    4. Drain Duty: Hose-end drain valves.
B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

3.04 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install shutoff valve immediately upstream of each dielectric fitting.

C. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

D. Install domestic water piping level and plumb.

E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install piping adjacent to equipment and specialties to allow service and maintenance.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

O. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

P. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

Q. Install sleeves and mechanical sleeve seals per the requirements of Division 22 Section “Common Work Results for Plumbing”.

R. Install pressure-seal pipe and fittings per manufacturer’s most current installation guidelines.

3.05 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use ball or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.06 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.
2. NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.07 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.08 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
3. Multiple, Straight, Horizontal Piping Runs: Field fabricated, heavy duty trapeze. Fabricate from steel shapes required for loads.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install supports for vertical copper tubing every 10 feet.

E. Install supports for vertical steel piping every 15 feet.

F. Install hangers for horizontal piping with the following minimum rod sizes and maximum spacing for trapeze type hangers with multiple rise runs of varying sizes. The hangers shall be spaced based upon the smallest diameter pipe.

Nom. Pipe Size – Inches	Steel Pipe Max. Span – Ft.	Copper Tube Max. Span – Ft.	Min. Rod Dia. - Inches
Up to ¾	7	5	3/8
1	7	6	3/8
1-1/4	7	6	3/8
1-1/2	9	6	3/8
2	10	8	3/8
2-1/2	11	9	½
3	12	10	½
3-1/2	12	10	½
4	12	10	½
5	12	10	5/8
6	12	10	¾
8	12	10	7/8

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.09 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 Plumbing Fixture Sections for connection sizes.
   2. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.10 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors. Escutcheons in areas exposed to view shall have a chrome plated finish.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
C. Piping Tests: The following minimum tests shall be performed. Review procedures with the local jurisdiction and provide any additional tests or procedures required. For manufactured piping systems, pressure/leak test in accordance with the manufacturer's standards.
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 1.5 times the normal operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and for corrective action required.
D. Domestic water piping will be considered defective if it does not pass tests and inspections.
E. Submit test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.14 CLEANING

A. Provide the following minimum cleaning and disinfecting procedures as follows. Notify the Engineer seven (7) days in advance of disinfection procedures.
    1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
    2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures as described below:
        a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
        b. Fill and isolate system according to either of the following:
            1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
            2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
        c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
        d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
B. Prepare and submit reports of purging and disinfecting activities.
C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate and maintain the domestic water piping systems. Refer to Division 01 Section "Demonstration and Training."
    1. Required Time: As required.

END OF SECTION 22 11 16

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Vacuum breakers.
   2. Backflow preventers.
   3. Water pressure-reducing valves.
   4. Balancing valves.
   5. Temperature-actuated water mixing valves.
   6. Strainers.
   7. Outlet boxes.
   8. Hose bibbs.
   9. Wall hydrants.
   10. Drain valves.
   11. Water hammer arresters.

1.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated. Provide power, signal, and control wiring diagrams if applicable.

1.04 CLOSEOUT DOCUMENTATION

A. Record Documents: Submit record documents in accordance with the requirements in Division 1 Section "Project Record Documents."

B. Maintenance Manuals: Submit maintenance data in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
   1. For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

C. Submit field quality control reports.

D. Submit test reports for backflow prevention devices to the authorities having jurisdiction.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance: Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

C. Lead Free Requirements: All plumbing pipes, fittings, valves, fixtures, and other components in systems providing water for human consumption shall be ‘lead-free’ in accordance with the “Reduction of Lead in Drinking Water Act” and the “Safe Drinking Water Act”, where the term ‘lead-free’ is defined to mean – “not containing more than 0.2 percent lead when used with respect to solder and flux; and not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.”
   1. Lead-free products shall be compliant with the requirements of either NSF 61-G or NSF 372.
   2. Lead-free products shall bear a certified mark by a nationally accredited certification body.

PART 2 PRODUCTS

2.01 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Standard: ASSE 1001.
   2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   3. Body: Bronze.
   4. Inlet and Outlet Connections: Threaded.
   5. Finish: Rough bronze in mechanical or boiler room. Chrome plated in all other areas.

B. Hose-Connection Vacuum Breakers:
   1. Standard: ASSE 1011.
   2. Body: Bronze, nonremovable, with manual drain.
   3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
   4. Finish: Rough bronze in mechanical rooms or boiler rooms. Chrome plated in all other areas.
C. Pressure Vacuum Breakers:
   1. Standard: ASSE 1020.
   2. Operation: Continuous-pressure applications.
   3. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
   4. Size: Full line size as indicated on drawings.
   5. Valves: Ball type, on inlet and outlet.

2.02 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers
   1. Standard: ASSE 1013.
   2. Operation: Continuous-pressure applications.
   3. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
   4. Temperature Rating: Backflow preventer shall be selected to operate at maximum temperature allowable of connected equipment, i.e. approximately 200 degrees Fahrenheit for boilers to be verified with manufacturer prior to final selection.
   5. Size: Full line size as indicated on drawings.
   6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
   7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   8. Configuration: Designed specifically for horizontal or vertical flow as installed.
   9. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
      b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
B. Beverage-Dispensing-Equipment Backflow Preventers:
   1. Standard: ASSE 1022.
   2. Operation: Continuous-pressure applications.
   3. Size: NPS 1/4 or NPS 3/8.
   4. Body: Stainless steel.
   5. End Connections: Threaded.
C. Hose-Connection Backflow Preventers:
   1. Standard: ASSE 1052.
   2. Operation: Up to 10-foot head of water back pressure.
   3. Inlet Size: NPS 1/2 or NPS 3/4.
   4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
   5. Capacity: At least 3-gpm flow.

2.03 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. Watts Industries, Inc.; Water Products Div.
      c. Zurn Plumbing Products Group; Wilkins Div.
   2. Standard: ASSE 1003.
   3. Pressure Rating: Initial working pressure of 150 psig.
   4. Size: Full line size as indicated on drawing.
   5. Design Flow Rate: Refer to drawings.

6. Design Inlet Pressure: Refer to drawings.
7. Design Outlet Pressure Setting: Refer to drawings.
8. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that is FDA approved for NPS 2-1/2 and larger.
9. Valves for Booster Heater Water Supply: Include integral bypass.
10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.04 BALANCING VALVES

A. Thermostatic Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Therm-Omega-Tech, Inc., Circuit Solver Thermostatic Recirculation Valve CSUA (TRV).
2. Standard: ANSI/AWWA C800 compliant.
3. Pressure Rating: 200-psig maximum working pressure, for sizes NPS 1/2 to NPS 2.
4. Temperature Rating: 300 deg. F maximum working temperature.
5. Size: NPS ½ to NPS 2.
6. Body Material: Stainless steel.
7. End Connections: Standard tapered female thread, NPT.
8. Thermal Actuator: Spring operated and self cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits. Rated for a minimum of 200,000 cycles.
9. Thermal Actuator Operation: Factory adjustable from 105 deg. F to 140 deg. F as required by project conditions. Fully open TRV shall modulate toward a minimum closed position upon sensing a water temperature above three deg. F of set point. When full closed the TRV shall bypass a minimum of 0.1 gpm water to maintain dynamic control of the recirculating loop.
10. TRV assembly shall come with an integral check valve.
11. TRV assembly shall come with lead free ball type shutoff valves on both sides per 22 05 23 “General Duty Valves for Plumbing Piping.”
12. TRV assembly shall come with an integral union.

B. Copper-Alloy and Stainless Steel Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watts Industries, Inc.; Water Products Div.
   b. Nibco, Inc.
   c. Nexus Valves
   d. HDi, Hydronic Components, Inc.
2. Type: Ball or Globe valve with two readout ports and memory setting indicator.
3. Body: Lead free brass, bronze or stainless steel.
4. Size: Same as connected piping, but not larger than NPS 2.

C. Cast-Iron Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Flo Fab Inc.
   c. Tour and Anderson, available through Victaulic Company of America
   d. NIBCO INC.
   e. Watts Industries, Inc.; Water Products Div.
   f. Gerand Engineering, Co.
   g. Taco, Inc.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

2.05 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Point-of-Use, Thermostatic, Water Mixing Valves.
1. Manufacturers: Subject to compliance with requirements. Provide products by one of the following:
   a. Apollo Valves, Conbraco Industries, Inc.
   b. Chicago Faucets.

c. Lawler Manufacturing Company, Inc.
d. Powers; a Watts Industries Co.
2. Standard: ASSE 1016 and ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Dual outlet, thermostatically controlled temperature limiting water mixing valve.
5. Material: Bronze body with PPO Noryl Shuttle, EPDM o-ring, wax-filled copper thermostat, 316 SS spring, and ABS handle.
6. Connections: Standard 7/8”
7. Accessories: Control knob, tamper resistant temperature limit stop, crush proof integral check valves, hot/cold water failure protection, cold water bypass for dual control faucets, and mounting bracket.
8. Tempered-water setting: 110°F.

2.06 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Drain: Factory-installed, hose-end drain valve.

2.07 OUTLET BOXES

A. Clothes Washer Outlet Boxes:
1. Mounting: Recessed.
2. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
3. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Supply Shutoff Fittings: Ball valves, copper, water tubing.
5. Drain: Standpipe and P-trap for direct waste connection to drainage piping. Refer to drawings for size required.
6. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
7. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Refrigerator, Coffee Maker, or Ice Maker Outlet Boxes:
1. Mounting: Recessed.
2. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
4. Supply Shutoff Fitting: Ball valves and NPS 1/2 copper, water tubing.

2.08 HOSE BIBBS

A. Hose Bibbs:
1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: Full line size as indicated on the drawings, threaded or soldered joints.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Finished Rooms: Chrome or nickel plated.

10. Operation for Equipment Rooms: Wheel handle or operating key.
11. Operation for Finished Rooms: Wheel handle or Operating key.
12. Include operating key with each operating-key hose bibb.
13. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.09 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: Full line size as indicated on the drawings.
6. Outlet: Concealed, with integral vacuum breaker complying with ASSE 1052 and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounting with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet: Exposed, with integral vacuum breaker complying with ASSE 1052 and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): Two with each wall hydrant.

2.10 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:
1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
4. Approved for installation with no access panel required.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.
1. All balancing valves shall be thermostatic type, except for at the master mixing valves where calibrated balancing valves shall be installed.

E. Install ASSE 1070 compliant point-of-use thermostatic mixing valves at all lavatory and wash fountain fixtures and as indicated in Section 22 40 00 Plumbing Fixture Data Sheets for specific fixtures requiring a temperature limiting device.

F. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Carpentry."

H. Install water hammer arresters in water piping according to PDI-WH 201 and at all quick-acting valves, including flush valves. Install water hammer arrestors as close as possible to the quick-acting valves.

I. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.04 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 11 19

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

1.02 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.03 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.
   2. Sanitary Sewer, Force-Main Piping: 100 psig.

1.04 SUBMITTALS

A. Provide product data for pipe, tube, fittings, and couplings.

1.05 CLOSEOUT DOCUMENTATION

A. Submit field quality control reports.

1.06 QUALITY ASSURANCE

A. Comply with the following Codes and Standards:
   1. Plumbing Code Compliance: Comply with applicable State Codes.
   2. CISPI: Cast Iron Soil Piping Institute.
   3. ASTM A 74: Standard Specifications for Hub and Spigot Cast Iron Soil Pipe and Fittings.
   4. ASTM C 564: Standard Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
   5. ASTM C 1277: Standard Shielded Couplings for Hubless Cast Iron Pipe and Fittings.
   6. ASTM C 1540: Heavy duty shielded couplings for Hubless Cast Iron Pipe and Fittings.

B. Piping material shall bear label, stamp, or other markings of specified testing agency.

C. All hubless cast iron DWV pipe and fittings shall be marked with Country of origin and identification of the original manufacturer.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Hubless Cast Iron Soil Pipe and Fittings: Conform to CISPI 301 and mark with the certified trademark of the independent third party certification agency.
   1. Standard shielded couplings: Conform to ASTM C1277 assembly. Provide with stainless steel metal shield, stainless steel bands and tightening devices and ASTM C564 rubber sleeve with integral center pipe stop.
   2. Heavy duty shielded couplings: Conform to ASTM C1540. Provide with stainless steel metal shield, stainless steel bands and tightening devices and ASTM C564 rubber sleeve with integral center pipe stop.

B. PVC sewer pipe and fittings. Conform to ASTM D2665 for pipe and fittings with solvent welded joints using solvents conforming to ASTM D2564. Primer color shall be purple to contrast with pipe and cement colors. Primer shall conform to ASTM F656.

C. Copper Tube: ASTM B 306, Type DWV, Tube, drawn temper with ASTM B16.23 wrought copper solder joint fittings.

PART 3 EXECUTION

3.01 PIPE APPLICATIONS

A. If more than one pipe material is listed for a piping system, selection from materials listed is the contractor's option.

B. Above Ground: Install PVC Sewer pipe and fittings or hubless cast iron soil pipe and fittings with heavy duty shielded couplings.

C. Below Ground:
   1. Install PVC sewer pipe and fittings.
D. Indirect Waste: InstallType DWV, drawn copper tube with wrought copper fittings and solder joints. This includes but is not limited to louver drain piping.

3.02 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all drainage and vent piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
B. Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.
C. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.
D. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.
E. Review soil testing information provided to verify conditions are suitable for piping installations.
F. Do not proceed until unsatisfactory conditions have been corrected.

3.03 UNDERGROUND PIPE INSTALLATION

A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.
B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated invert elevation.
C. Shape bottom of trench to fit bottom ½ of the circumference of pipe. Fill unevenness with tamped granular sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.
D. Install underground building drains to conform with State Plumbing Code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual and Handbook. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
E. Backfill trench with clean sand or gravel. Removed trench soil may be used as backfill if suitable compaction can be obtained.
F. Install building drain pitched down at minimum slope of 1/4" per foot (2 percent). Where site conditions preclude this slope, pipes 4-inch and larger may be sloped at 1/8” per foot (1 percent). Notify Engineer of site conditions that do not allow sloping of pipe at ¼” per foot. Approval from authority having jurisdiction is required prior to proceeding with the Work.
G. Extend building drain to connect to sewer piping, of size and in location indicated for service entrance to building. Sewer piping is specified in a separate section of Division 2.
H. Install sleeve and mechanical sleeve seal through foundation wall for watertight installation.
I. Install 1" thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend minimum of 12" beyond each side of pipe. Install directly over, and center on pipe center line.
J. Make changes of direction using appropriate 45 degree wyes or long sweep bends. No change of direction in flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

3.04 JOINING PIPES AND FITTINGS

A. Cast-Iron Soil Pipe: Hubless joints shall be supported and restrained in accordance with ASTM 1540/CISPI 310 standards.
B. Soldered Joints: Use ASTM B813, water-flushable, lead-free flux; ASTM B32, lead-free-alloy solder, and ASTM B828 procedures, unless otherwise indicated.

3.05 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Install individual, straight, horizontal piping runs: MSS Type 1, adjustable, steel clevis hangers.
   3. Multiple, Straight, Horizontal Piping Runs: MSS SP-69 and MSS SP-89, field-fabricated trapeze pipe hangers.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor. Support vertical cast iron piping at a minimum of every 15 feet. Support vertical copper tubing at a minimum every 10 feet.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers with the following minimum rod sizes and maximum spacing in accordance with state code. For cast iron pipe. Install hangers at each branch connection and at every joint unless over 4-feet, then at each joint.

Nom. Pipe Size – Inches	Cast Iron Pipe Max. Span – Feet	Copper Tube Max. Span – Feet	Min. Rod Dia. – Inches
Up to 3/4	--	5	3/8
1	--	6	3/8
1¼	7	6	3/8
1½	9	6	3/8
2	10	8	3/8
2½	10	9	3/8
3	10	10	3/8
4	10	10	5/8
5	10	10	5/8
6	10	10	3/4
8	10	10	7/8
10	10	10	7/8
12	10	10	7/8

F. The following additional cast iron hanger requirements shall apply:
   1. Support adjacent to joint, not to exceed 18 inches.
   2. Brace not to exceed 40 foot intervals to prevent horizontal movement.
   3. Support at each horizontal branch connection.
   4. Hangers shall not be placed on the coupling.

G. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3.07 FIELD QUALITY CONTROL

A. Inspections:
1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests in accordance with State and Local code requirements in the presence of the plumbing official.
   a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
   b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the State Plumbing Code.
3. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspection by the plumbing official.
4. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test:
1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. In the absence of State or Local code requirements, the following minimum level of testing shall be performed. Drainage and Venting System Testing Procedures:
   a. Rough Plumbing: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation as follows:
      1) Cast Iron Piping Systems:
         (a) Attach an air compressor or testing apparatus to any suitable opening and close all other inlets and outlets to the system by means of proper testing plugs. Plaster of paris shall not be used in roof terminals. Air shall be forced tinto the system until there is a uniform pressure of five piunds per square inch on the portion of the system being tested. The pressure shall remain constant for 15 minutes without the addition of air.
      2) Thermoplastic Piping Systems:
         (a) Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts through completion of the inspection. Inspect all joints for leaks. The contractor shall pre-test the systems with air when necessary to avoid possible damage to finished materials and surfaces.
   b. Finished Plumbing: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Plug the stack openings on the roof and building drain where it leaves the building, and introduce air into the system equal to a pressure of 1" water column. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure shall remain constant without the introduction of additional air throughout the period of inspection. Inspect all plumbing fixture connections for gas and water leaks.

4. Repair all leaks and defects using new materials and re-test system or portion thereof until satisfactory results are obtained.
5. Prepare reports for all tests and required corrective action.

3.08 ADJUSTING AND CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.
B. Clean drain strainers, domes, and traps. Remove dirt and debris.
C. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
D. Place plugs in ends of unoccupied piping at end of day and when work stops.

3.09 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 22 13 16

SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Roof flashing assemblies.
   4. Through-penetration firestop assemblies.
   5. Miscellaneous sanitary drainage piping specialties.
   6. Flashing materials.

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.
B. FOG: Fats, oils, and greases.
C. FRP: Fiberglass-reinforced plastic.
D. HDPE: High-density polyethylene plastic.
E. PE: Polyethylene plastic.
F. PP: Polypropylene plastic.
G. PVC: Polyvinyl chloride plastic.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated. Include rated capacities, operating characteristics, and accessories.

1.04 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
   1. For drainage piping specialties to include in emergency, operation, and maintenance manuals.
B. Submit field quality control reports.

1.05 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 CLEANOUTS

A. Metal Cleanouts:
   1. Standard: ASME A112.36.2M cast iron for cleanout test tee.
   2. Size: Same as connected drainage piping.
   3. Body Material: Match connected piping material and connection method.
   4. Closure: Countersunk plug.
   5. Options – Floor Cleanouts
      a. Closure: Brass plug with straight threads and gasket.
      b. Adjustable Housing Material: Cast iron with threads.
      c. Frame and Cover Material:
         1) Finished Areas: Polished bronze.
         2) Unfinished Areas: Rough bronze.
         3) Carpeted Areas: Stainless steel carpet marker with vandal proof screw.

6. Options – Wall Cleanouts
    a. Closure: Countersunk brass plug.
    b. Closure Size: Same as cleanout size.
    c. Wall Access: Round, flat, chrome plated brass coverplate with screw.

2.02 FLOOR DRAINS

A. Subject to compliance with requirements, provide drainage systems from one of the following:
    1. Josam Mfg. Co.
    2. Smith (Jay R) Mfg. Co.
    3. Wade, Subs. of McWane
    4. Zurn Industries Inc,; Hydromechanics Div.
    5. Watts Regulator Company
    6. Mifab

B. General: Provide floor drains of size as indicated on drawings; and type, including features, as specified herein: (Typical units listed below are of Josam manufacture).

C. Floor Drain Type FD-1: Coated cast iron floor drain of the size indicated on the plans, with double drainage flange, invertible non-puncturing flashing collar, weepholes, bottom outlet, and adjustable satin nikaloy round "Super-Flo" strainer of 6 inch diameter or as indicated on drawings. Josam Series No. 30000-A.
    1. These drains are for use in toilet rooms, showers, service sinks and other finished areas.
    2. Where floor drains with funnels are shown, provide Josam Option ‘E2’ round funnel. Field welded funnels on strainers are not acceptable.
    3. Where floor drains with backwater valves are shown, provide with Josam Option ‘J’ internal backwater valve.

D. Floor Drain Type FD-2: Coated cast iron floor drain of the size indicated on the plans, with double drainage flange, invertible non-puncturing flashing collar, weepholes, bottom outlet, and adjustable bronze round "Super-Flo" strainer of 6 inch diameter or as indicated on drawings. Josam Series No. 30000-A-2.
    1. These drains are for use in mechanical rooms, elevator shafts, and other unfinished areas.
    2. Where floor drains with funnels are shown, provide Josam Option ‘E2’ round funnel. Field welded funnels on strainers are not acceptable.
    3. Drain shall be installed with a deep seal trap.
    4. Where floor drains with backwater valves are shown, provide with Josam Option ‘J’ internal backwater valve.

2.03 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

B. Description: Manufactured assembly made of 6.0-lb/sq. ft. thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
    1. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.04 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:
    1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
    2. Size: Same as connected waste piping.
        a. NPS 2: 4-inch minimum water seal.
        b. NPS 2-1/2and Larger: 5-inch minimum water seal.

B. Air-Gap Fittings:
    1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
    2. Body: Bronze or cast iron.
    3. Inlet: Opening in top of body.
    4. Outlet: Larger than inlet.
    5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.
D. Stack Flashing Fittings:
   1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.
E. Vent Caps:
   1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
   2. Size: Same as connected stack vent or vent stack.

2.05 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
   2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
   3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz./sq. ft.
   2. Vent Pipe Flashing: 8 oz./sq. ft..
C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
E. Fasteners: Metal compatible with material and substrate being fastened.
F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
G. Solder: ASTM B 32, lead-free alloy.
H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.
   5. Locate where there is an increase in pipe size.
   6. Locate at new to existing piping connections.
   7. Locate at fixtures that are common vented at the same level.
   8. Locate at upper most terminal of horizontal drains where traps are concealed, so that all lines are accessible for cleaning.
   9. Locate inside the building near the connection between the building drain and the building sewer.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
    1. Position floor drains for easy access and maintenance.
    2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
    3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
    4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
H. Install deep-seal traps on floor drains and other waste outlets, if indicated.
I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
J. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
K. Install vent caps on each vent pipe passing through roof.
L. Install wood-blocking reinforcement for wall-mounting-type specialties.
M. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

3.03 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
    1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
    2. Copper Sheets: Solder joints of copper sheets.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
    1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
    2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
    3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Coping and Flashing."
F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
    1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled their installation, including piping and electrical connections, and to assist in testing.
B. Tests and Inspections:
    1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.05 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 31 00
WATER SOFTENERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes commercial water softening equipment.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories. Include power, signal, and control wiring diagrams if applicable.

1.03 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".

B. Warranty: Submit special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. NSF Standard: Provide water softeners constructed in accordance with NSF No. 44 "Standard for Cation Exchange Water Softeners."

B. Mineral Standard: Provide mineral (resin) products acceptable under state and local public health control regulations.

C. Electrical Component Standard: Provide components complying with NFPA 70 "National Electrical Code."

D. Listing and Labeling: Provide water softening equipment that is listed or labeled. Upon request, submit evidence of such qualifications to the Architect.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. State Plumbing Code Compliance: Comply with applicable provisions of State Building Code in the design, manufacture and installation of water softener.

F. Manufacturer/Product Selection: The Drawings indicate sizes, profiles, and dimensional requirements of water softeners. Water softeners having equal performance characteristics with deviations from indicated dimensions and profiles may be considered, provided deviations do not change the design concept or intended performance. The burden of proof of equality is on the proposer.

G. Lead Free Requirements: All plumbing pipes, fittings, valves, fixtures, and other components in systems providing water for human consumption shall be ‘lead-free’ in accordance with the “Reduction of Lead in Drinking Water Act” and the “Safe Drinking Water Act”, where the term ‘lead-free’ is defined to mean – “not containing more than 0.2 percent lead when used with respect to solder and flux; and not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.”

1. Lead-free products shall be compliant with the requirements of either NSF 61-G or NSF 372.
2. Lead-free products shall bear a certified mark by a nationally accredited certification body.

1.05 WARRANTY

A. Provide standard product warranty for water softeners covering:

1. Attrition loss of mineral not to exceed 3 percent per year for first 3 years.
2. Mineral not to be washed out of system during service run or backwashing period.
3. Effluent turbidity not to be greater and color not to be darker than incoming water.
4. Underdrain system, gravel, and mineral not to become fouled, either with turbidity or by dirt, rust, or scale from softening system, or present in soft water, while operating as noted in manufacturer's operating instructions.

1.06 MAINTENANCE SERVICE

A. Agreement to Maintain: Prior to Substantial Completion, submit 4 copies of Manufacturer's "Agreement for Continued Service and Maintenance" for water softener, for Owner's acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing to include replacing materials and equipment. Term of agreement shall be for 1 year with option for one-year renewal.

1.07 EXTRA MATERIALS

A. Furnish extra materials listed below, matching installed products, packaged with protective covering for storage, and identified with labels clearly describing contents.
   1. Salt: Furnish salt in total quantity of not less than 4 times original brine tank load, and not less than 1000 lb. Deliver in 50-lb bags on pallets. Store where directed by Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include the following:
   1. Culligan International Co.
   2. US Filter
   3. Robert B. Hill
   4. Water Control Corporation
   5. Ecowater Systems

2.02 COMMERCIAL WATER SOFTENER

A. Factory-assembled, pressure-type, commercial water softeners having capacities and for electrical characteristics indicated.

B. Mineral Tanks:
   1. Construction: Non-ASME fiberglass reinforced plastic. Comply with NSF 61.
   2. Pressure Rating: 100 psig minimum.
   3. Welded Components: Suitable for temperatures from 40□F to 100□F.
   4. Freeboard: 50% minimum for backwash expansion above normal resin bed.
   5. Support Skirt: Molded polypropylene base.
   6. Upper Distribution System: Single point type fabricated from galvanized steel pipe and fittings.
   7. Lower Distribution: Hub and radial-arm or header-lateral type; fabricate from non-metallic pipe and fittings with individual, fine slotted, non-clogging plastic strainers. Arrange for even flow through resin bed.

C. Brine Tank: Combination measuring and wet salt storage system.
   1. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
   2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
   3. Size: Large enough for at least four regenerations at full salting.

D. Controls:
   1. Fully automatic; factory mounted on unit and factory wired.
   2. Programmable electronic controller with LCD display and status/programming indicators. The controller shall display status of each tank with respect to service or regeneration, time of day, volume remaining, flow rate, totalizer, dates since regeneration, and prior service, volume used.
   3. Adjustable duration of various regeneration steps.
   4. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
   5. Means of manual operation of pilot-control valve if power fails.
   6. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
      a. Slow opening and closing, nonslam operation.
      b. Diaphragm guiding on full perimeter from fully open to fully closed.
      c. Isolated dissimilar metals within valve.
      d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
      e. Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
      f. Sampling cocks for soft water.
      g. Special tools are not required for service.

7. Water Meter.
    a. The water softener manufacturer shall provide a water meter for each mineral tank. Meters shall be compatible with the controllers and shall produce an electrical signal indicating the need for regeneration. The electrical signal shall activate the controllers to automatically regenerate based on a preset total volume in gallons.
    b. For systems with multiple mineral tanks, the system shall have an electrical lockout preventing simultaneous regeneration of more than one tank.
    c. The controller shall reset after each regeneration such that the next service run occurs based upon the subsequent preset total volume.
    d. Range and accuracy.
        1) Meters shall be capable of measuring flow rates within the range of 1% to 100% of the total design flow rate at 15 psi (see equipment schedule on drawings). For systems with total flow rates less than 50 gpm, the meter's minimum range is not required to extend below 0.5 gpm.
        2) Meter accuracy over the flow rate range shall be +/- 5%.
    e. Provide reducer fittings as required to transition between the meter size, main operating valve size, and system manifold size.
8. For systems with multiple softener tanks, provide progressive softener tank operation based on water flow. Allow one softener tank to regenerate while the other is in service.
9. Provide with brine reclamation to reduce salt usage.

E. Factory-Installed Accessories:
1. Piping, valves, tubing, and drains.
2. Sampling cock.
3. Main-operating-valve position indicator.

2.03 CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
1. Exchange Capacity: 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.

B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.
1. Form: Processed, food-grade salt pellets.

2.04 ACCESSORIES

A. Pressure gages for hard water inlet and soft water outlet.
B. Sampling cocks for hard water inlet and soft water outlet for each tank.
C. Position indicator to indicate position of main operating valve.

PART 3 EXECUTION

3.01 WATER SOFTENER INSTALLATION

A. Install water softening equipment level and plumb, in accordance with manufacturer's written instructions, layout drawings, the original design, and referenced standards. Maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.
B. Install pressure gages on water inlet and outlet piping of each water softener. Pressure gages are specified in Division 22 Section 22 05 19 "Meters and Gages."

3.02 CONNECTIONS

A. Water Distribution Piping: Piping installation requirements are specified in Division 22 Section 22 11 16 "Domestic Water Piping." The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
1. Install piping adjacent to equipment to allow servicing and maintenance.

2. Connect water piping to units with shutoff valves and unions and provide full-size valved bypass around unit.
    a. Where water connections are made with dissimilar metal water distribution piping, make connections with dielectric fittings or dielectric unions.
3. Install drains as indirect wastes to spill into open drains or over floor drains.

B. Install brine lines and fittings furnished by manufacturer but not specified to be factory mounted.

C. Electrical Connections: Power wiring, including disconnect switches, is specified in Division 16.
1. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.03 FIELD QUALITY CONTROL

A. Sample water softener effluent at one week intervals after start-up, for period of 3 weeks and prepare certified test report for each required water performance characteristic. Comply with the following ASTM standards:
1. ASTM D 859-80, "Test Methods for Silica in Water."
2. ASTM D 1067-82, "Test Methods for Acidity or Alkalinity of Water."
3. ASTM D 1068-87, "Test Methods for Iron in Water."
4. ASTM D 1126-86, "Test Methods for Hardness in Water."
5. ASTM D 1129-82b, "Definitions of Terms Relating to Water."
6. ASTM D 1888-78, "Test Methods for Particulate and Dissolved Matter in Water."
7. ASTM D 3370-82, "Practices for Sampling Water."

3.04 SYSTEM START-UP

A. Perform the following before start-up final checks:
1. Water piping systems tests completed.
2. Load Softener Tank: Install gravel to cover lower distribution system, add water; smooth gravel surface and add softening mineral.
3. Load Brine Tank: Add water and fill tank with salt.
4. Check for piping connections leaks.
5. Test operation of safety controls and devices.

B. Perform the following start-up procedures:
1. Energize circuits.
2. Adjust operating controls.

END OF SECTION 22 31 00

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Water closets
   2. Shower mixing valve assemblies
   3. Lavatories
   4. Stainless steel sinks
   5. Faucets
   6. Drains
   7. Wastes
   8. Service sinks
   9. Laundry sinks
   10. Service receptors
   11. Water coolers
   12. Water filters
   13. Supplies with angle stops
   14. Point of use mixing valves
   15. Fixture by others

B. Products installed but not furnished under this Section include:
   1. Owner-supplied fixtures, as indicated.
   2. Accessories, appliances, appurtenances, and equipment specified in other sections, requiring plumbing services or fixture- related devices, as indicated.

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.03 SUBMITTALS

A. Provide product data for each type of plumbing fixture indicated. Include fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes. Include power, signal, and control wiring diagram for electrically operated plumbing fixtures.

B. Provide color charts of manufacturer's standard options. Upon request, submit physical color samples to the Architect. If a custom color is specified, provide a physical color sample to the Architect for verification prior to production.

1.04 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
   1. For plumbing fixtures to includes emergency operation and maintenance manuals.

B. Warranty: Submit special warranty specified in this Section.
C. Submit field quality control reports.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" as required by State Code for plumbing fixtures for people with disabilities.
D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
F. Lead Free Requirements: All plumbing pipes, fittings, valves, fixtures, and other components in systems providing water for human consumption shall be 'lead-free' in accordance with the "Reduction of Lead in Drinking Water Act" and the "Safe Drinking Water Act", where the term 'lead-free' is defined to mean – "not containing more than 0.2 percent lead when used with respect to solder and flux; and not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures."
   1. Lead-free products shall be compliant with the requirements of either NSF 61-G or NSF 372.
   2. Lead-free products shall bear a certified mark by a nationally accredited certification body.

   Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Plastic Laundry Trays: ANSI Z124.6.
   3. Plastic Mop-Service Basins: ANSI Z124.6.
   4. Plastic Shower Enclosures: ANSI Z124.2.
   5. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   6. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
   7. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
   8. Vitreous-China Fixtures: ASME A112.19.2M.
   9. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
   10. Water-Closet, Flushometer Tank Trim: ASSE 1037.
H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
   4. Faucets: ASME A112.18.1.
   5. Hose-Connection Vacuum Breakers: ASSE 1011.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   8. NSF Potable-Water Materials: NSF 61.
   9. Pipe Threads: ASME B1.20.1.
   10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   11. Supply Fittings: ASME A112.18.1.
   12. Brass Waste Fittings: ASME A112.18.2.
   13. Point-of-Use Thermostatic Mixing Valves: ASSE 1070.

I. Comply with the following applicable standards and other requirements specified for shower faucets:
   1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
   2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
   3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
   4. Faucets: ASME A112.18.1.
   5. Hand-Held Showers: ASSE 1014.
   6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
   7. Hose-Coupling Threads: ASME B1.20.7.
   8. Manual-Control Antiscald Faucets: ASTM F 444.
   9. Pipe Threads: ASME B1.20.1.
   10. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
   11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   12. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   1. Atmospheric Vacuum Breakers: ASSE 1001.
   2. Brass and Copper Supplies: ASME A112.18.1.
   3. Dishwasher Air-Gap Fittings: ASSE 1021.
   4. Manual-Operation Flushometers: ASSE 1037.
   5. Plastic Tubular Fittings: ASTM F 409.
   6. Brass Waste Fittings: ASME A112.18.2.
   7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Disposers: ASSE 1008 and UL 430.
   2. Dishwasher Air-Gap Fittings: ASSE 1021.
   3. Flexible Water Connectors: ASME A112.18.6.
   4. Floor Drains: ASME A112.6.3.
   5. Grab Bars: ASTM F 446.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Hot-Water Dispensers: ASSE 1023 and UL 499.
   8. Off-Floor Fixture Supports: ASME A112.6.1M.
   9. Pipe Threads: ASME B1.20.1.
   10. Plastic Shower Receptors: ANSI Z124.2.
   11. Plastic Toilet Seats: ANSI Z124.5.
   12. Supply and Drain Protective Shielding Guards: ICC A117.1. ASTM E-84 with a flame index under 25 and smoke index of not more than 450.

1.06 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Commercial Applications: One year from date of Substantial Completion.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
   3. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
   4. Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.
   5. Toilet Seats: Equal to 5 percent of amount of each type installed.
   6. Electric Water Cooler Strainers: Equal to 100 percent of the amount installed.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.

B. Store plumbing fixtures on elevated platforms in a dry location.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following for each fixture type or component listed.

1. Vitreous China Fixtures:
    a. American Standard
    b. Crane
    c. Eljer
    d. Kohler
    e. Zurn One
    f. Sloan
2. Stainless Steel Counter Sinks:
    a. Elkay
    b. Just
3. Faucets:
    a. Chicago
    b. Delta
    c. Zurn Aqua Spec
    d. T&S Brass
4. Mop Basin:
    a. Fiat
    b. Stern-Williams
    c. Mustee
    d. Acorn
    e. Zurn
5. Showers:
    a. Chicago
    b. Symmons
    c. Powers
    d. Zurn Temp Guard
    e. Leonard
    f. Delta Commercial
6. Water Cooler:
    a. Halsey-Taylor
    b. Elkay
7. Enameled Cast Iron Fixtures:
    a. American Standard
    b. Crane
    c. Eljer
    d. Kohler
    e. Zurn One
8. ADA Trap Wrap:
    a. Truebro
    b. Handi Lav-Guard
    c. Brocer Products
    d. Trap Wrap

e. Pro Wrap
f. Zurn
g. Proflo

9. Toilet Seats:
   a. American Standard
   b. Church
   c. Bereke
   d. Olsonite
   e. Sperzel
   f. Centoco
   g. Proflo
   h. Zurn
   i. Bemis
10. Plumbing Supports:
   a. Josam
   b. Wade
   c. Smith
   d. Zurn
   e. Watts
   f. Mifab
11. Traps and Supplies:
   a. Zurn Traps and Supplies
   b. Chicago
   c. Brass Craft
   d. Central
   e. Royal
   f. Dearborn
   g. T&S
   h. Keeney

2.02 PLUMBING FIXTURES, GENERAL

A. Provide plumbing fixtures and trim, fittings, other components, and supports as specified in "Plumbing Fixture Data Sheets" at the end of Part 3 of this Section.

B. Provide plumbing fixtures and trim, fittings and other components that are certified in accordance with NSF 61 and NSF Annex G to contain less than 0.25% lead content, for all products in contact with drinking water.

2.03 FAUCETS

A. Faucets General: Unless otherwise indicated, provide faucets that are solid, one piece cast brass with polished, heavy chrome-plate finish conforming to ASME A-112.18.1M. Lead content shall be less than 0.25%.

2.04 FITTINGS, EXCEPT FAUCETS

A. Fittings General: Unless otherwise specified, provide fitting fabricated of brass, with polished heavy chrome plate finish.

B. Escutcheons: Wall flange with set screw or sheet steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

2.05 SUPPLIES WITH ANGLE STOPS

A. Construction: Polished chrome plated solid brass construction. Plastic stems are not allowed.

B. Cartridge: Ball valve.

C. Supply Riser: 3/8” O.D. x 12” flexible copper, chrome plated supply riser.

D. Handle: Removable, chrome plated, 2 ¼” metal loose key tee.

E. Escutcheon: Chrome plated metal wall flange.

F. Performance:
   1. 20-125 psi rated operating pressure.
   2. 40-140°F rated operating temperature.
G. Codes: ASME A112.18.1M.

2.06 TOILET SEATS

A. General: Provide toilet seats compatible with water closets, and of type, color, and features indicated.
B. Toilet Seats: Heavy-duty, commercial/industrial type, elongated, open front, solid plastic, with self-sustaining check hinge, less cover.

2.07 WATER FILTER FOR WATER COOLERS

A. Capacity of 3000 gallons, 1.5 GPM, 105 psi. Conform to NSF/ANSI 42 and 53 for chlorine taste, odor, particulate Class 1 and lead reduction. Filter shall be integral to water cooler and installed in the factory.

2.08 PLUMBING FIXTURE SUPPORTS

A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.
B. Support categories are:
   1. Water Closet Carriers: Supports for wall-hanging water closets. Provided coated cast iron, floor-mounted carrier with adjustable connection and rough-in height, adjustable feet, ABS extension with integral test cap, chrome plated trim, coated accessories,and neoprene fixture gasket. Provide with cast iron, adjustable anchor feet for stability. Water closet carriers shall have an additional faceplate and coupling when used for wide pipe spaces. Provide tiling frame or setting gage with carriers for wall-hanging water closets. Long barrel in vertical applications.
   2. Sink or Similar Fixture Carriers: Supports for wall-hanging sinks, lavatories or similar fixtures. Provide floor-mounted welded feet and supports with steel uprights and concealed arms. Provide with leveling and securing screws. Verify arm type with fixture.
   3. Urinal Carrier: Supports for wall hanging urinal. Provide floor-mounted welded feet and supports with steel upright, upper hanger plate, lower bearing plate and adjustable supporting rods.
   4. Water Cooler Carrier: Supports for wall hanging water cooler. Provide floor mounted welded feet and supports with steel uprights, upper hanger plate, lower bearing plate, adjustable rods and chrome plated trim. Provide bi-level type for bi-level water cooler.
   5. Reinforcement: 2-inch by 4-inch wood blocking between studs or 1/4-inch by 6-inch steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.
C. Support Types: Provide support of category specified, of type having features required to match fixture.
D. Provide supports specified if a part of fixture description, in lieu of category and type requirements above.
E. Subject to compliance with requirements, provide plumbing fixture supports from one of the following:
   1. Josam Mfg. Co.
   2. Smith (Jay R.) Mfg. Co.
   3. Wade; Subs of Tyler Pipe Corp.
   4. Zurn Industries; Hydromechanics Division
   5. Watts Drainage
   6. Mifab

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for potable cold water and hot water supplies and soil, waste, and vent piping systems to verify actual locations of piping connections prior to installing fixtures.
B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 APPLICATION

A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.

B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:
   1. Carriers for following fixtures:
      a. Wall-hanging fixtures supported from wall construction.
   2. Chair carriers for the following fixtures:
      a. Wall-hanging lavatories and sinks.
      b. Wall-hanging drinking fountains and electric water coolers.
   3. Heavy-duty chair carriers for the following fixtures:
      a. Accessible lavatories.
      b. Fixtures where specified.
   4. Reinforcement for the following fixtures:
      a. Floor-mounted lavatories required to be secured to wall.
      b. Floor-mounted sinks required to be secured to wall.
      c. Recessed, box-mounted drinking fountains and water coolers.

3.03 INSTALLATION OF PLUMBING FIXTURES

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing- in drawings, and referenced standards.
B. Install floor-mounted, floor-outlet water closets with closet flanges and gasket seals.
C. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
D. Fasten floor-mounted fixtures and special fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
E. Fasten wall-mounted fittings to reinforcement built into walls.
F. Fasten counter-mounting-type plumbing fixtures to casework.
G. Secure supplies behind wall or within wall pipe space, providing rigid installation.
H. Set shower receptors and mop basins in leveling bed of cement grout.
I. Install stop valve in an accessible location in each water supply to each fixture.
J. Install trap on fixture outlet except for fixtures having integral trap.
K. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.
L. Seal fixtures to walls, floors, and counters using a sanitary-type, one-part, mildew-resistant, silicone sealant in accordance with sealing requirements specified in Division 7. Match sealant color to fixture color.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
   1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.
   2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3.05 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.06 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
C. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.

D. Replace washers or cartridges of leaking and dripping faucets and stops.
E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.
F. Review the data in Operating and Maintenance Manuals. Refer to Division 1 Section "Project Closeout."

3.07 PROTECTION

A. Provide protective covering for installed fixtures and fittings.
B. Do not allow use of fixtures for temporary facilities, except when approved in writing by the Owner.
C. Protect interceptors during construction period, to avoid clogging with construction materials and debris, and to prevent damage from construction debris and traffic.

3.08 FIXTURE SCHEDULE

A. Provide plumbing fixtures as scheduled on the following "Data Sheets." Each Data Sheet begins with a new page.

3.09 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate and maintain plumbing fixtures. Refer to Division 01 Section “Demonstration and Training.”
   1. Required Time: As required.

P-1 Water Closet

Fixture:

American Standard 270AA.001 Cadet / Kohler K-3589 Cimarron / Mansfield 384-386 Summit vitreous china, elongated bowl, 12" rough-in floor outlet, 16-1/2" rim height, fully glazed trapway, 1.6 gpf gravity flush siphon action toilet with close-coupled tank and lid, flush valve, anti-siphon water control ball cock, left or right side chrome trip lever and two bolt caps. Color white. Compliant with ASME A112.19.2 for vitreous china fixtures. Side trip lever shall be on the approach or wide side of the toilet in accessible rooms.

Supply Fittings:

Brass Craft / Dearborn or equal quarter turn angle valve, flexible riser and escutcheon, all chrome plated finish.

Waste Fittings:

Closet floor flange with hardware and wax ring gasket.

Accessories:

Bemis 1955SSCT / Church 295SSCT / Comfort Seats C106SSC / Olsonite 10SSCT molded plastic, elongated, open front seat (less cover) with self-sustaining check hinge, stainless steel posts, four bumpers, color white.

P-2 Lavatory

Fixture:

Countertop with integral bowl supplied by Division 12.

Supply Fittings:

Delta 22C651 faucet with 3-1/2” single lever control, ADA compliant, ceramic cartridge, high temperature limit stop, color coded hot/cold identification, integrated volume and temperature control, single hole mount, vandal-resistant 0.5 gpm non-aerating spray outlet, cast brass body with chrome finish, two 3/8” inlet tubes, metal hold-down package, nominal 5-1/2” to 7” height with 2-3/4” outlet height above fixture flood rim. Compliant with ASME A112.18.1. Two Brass Craft / Dearborn or equal quarter turn angle valves, flexible risers, and escutcheons.

Waste Fittings:

Perforated grid strainer, chrome plated, with 1-1/4” tailpiece, 1-1/4" adjustable P-trap with cleanout and tubing drain to wall with escutcheon.

Accessories:

Supply and waste insulation kit, Brocar Products / Plumberex / TCI Skal+Gard / Trap Wrap / Truebro Lav-Guard insulation kit, color white.

P-3 Shower

Fixture:

Other Divisions will construct ceramic tile shower compartment.

Supply Fittings:

Delta R10000-UNWS and T13H153-05 pressure balancing shower mixing valve with ADA compliant single lever handle, chrome finish cover plate with color-coded hot/cold identification, service stops, adjustable temperature limit stop screw, 1.5 gpm hand shower with 70" white vinyl hose, in-line vacuum breaker, supply elbow with escutcheon and 36" combination grab/slide bar. Valve shall comply with ASME A112.18.1. Pressure balancing valve shall meet ASSE 1016. ADA handle shall meet ASME 117.1. The in-line vacuum breaker shall comply with Minnesota Plumbing Code.

Refer to architectural elevations and details for all mounting heights.

Waste Fittings:

2” tailpiece and 2” P-trap. Refer to plumbing plans for floor drain type.

P-4 Mop Basin

Fixture:

Fiat MSBID-2424 / Mustee 63M / Stern Williams MTB-2424 / Swan MS-2424 / Zurn Z-1996-24-BS molded high density composite mop service basin, color off white, sloped to center drain, with vinyl or stainless steel bumper guards on exposed edges. Fixture dimensions: 24" x 24" x 10".

Supply Fittings:

Chicago 911-IS369XKCCP / Delta service sink faucet with 2-1/2" lever or cross handles with color hot and cold indicators, adjustable integral stop arms and check valves, ASSE 1001 elevated vacuum breaker, 5-1/2" long rigid spout with pail hook, wall brace, 3/4" hose thread outlet and rough chromium finish. Mount vacuum breaker at 7'-6" above finished floor. Faucet shall meet ASME A112.18.1M.

Waste Fittings:

Drain body and chrome plated strainer integral with basin with 3" caulk outlet. Provide 3" tailpiece and 3" P-trap.

P-5 Water Closet – Bariatric

Fixture:

American Standard 3641.001 Right Width FloWise floor mount, vitreous china, elongated bowl, flushometer valve toilet, 1.6 gpf, 10" rough-in floor outlet, ADA 17-1/4" rim height for accessible application, tested to support static load of 2,000 lbs, 17" bowl width, siphon jet action, fully glazed 2" trapway, 1-1/2" brass top spud inlet, two bolt caps, with white seat, fixture color white. Compliant with ASME A112.19.2 for vitreous china fixtures.

Supply Fittings:

Sloan Royal 111-1.6 / Zurn Z6000AV-WS1 exposed water closet flushometer, 1.6 gpf, chrome plated, ADA-compliant metal non hold open handle, 1" I.P.S. screwdriver back check angle stop, 11-1/2" rough-in height, adjustable tailpiece, vacuum breaker, 1-1/2" spud connection with spud coupling and flange, sweat solder adapter with cover tube and cast wall flange. Valve shall meet the applicable sections of ASSE 1037 and ASME A112.19.2.

Waste Fitting:

Closet floor flange with hardware and wax ring gasket.

P-6 Flushing Rim Sink

Fixture:

American Standard 9512.999.020 / Kohler K-12867 Camerton vitreous china, blowout action, wall hung, flushing rim sink with 1-1/2" brass top spud, integral trap, 4" outlet, 6.5 gpf and three 10” stainless steel rim guards. Color white. Compliant with ASME A112.19.2. Outside dimensions: 25-1/2” x 21” x 13-1/2”.

Supply Fittings:

Sloan 117-H / Zurn Z-6017AV-H exposed flushometer, 6.5 gpf, chrome plated, ADA-compliant metal non-hold open front handle, 1” I.P.S. screw driver back check angle stop, adjustable tailpiece, vacuum breaker, 1-1/2” spud connection with spud coupling and flange, sweat solder adapter with cover tube and cast wall flange. Valve shall be in compliance to the applicable sections of ASSE 1037, ASME A112.19.2.

Chicago 814-VBCP / Delta 28C2985 / Zurn Z-842D6-LS1-2XT faucet with 6" ADA wrist blade handles, supply arms with integral service stops and wall flange, 6” rigid spout with 3/4" hose threaded outlet, pail hook, ASSE 1001 vacuum breaker, wall brace, chrome plated. Compliant to ASME A112.18.1.

Accessory Spray Unit:

Chicago 910-G777-19KCP / Delta 54T1434A / Zurn Z85500-WM-EVB-HK-SE-SH2-VC bedpan sprayer, 1/2" loose key stops, double pedal valves, elevated ASSE 1001 vacuum breaker, 4'-0" white vinyl hose with angle spray nozzle, insulated handle and flanged elbow. Metal components shall have chrome plated finish.

Waste Fittings:

Josam / J.R.Smith / Mifab / Wade / Watts / Zurn or approved equal concealed floor mounted carrier with 4” waste pipe, anchor foot, neoprene or petrolatum felt gasket and mounting hardware.

P-7 Lavatory

Fixture:

American Standard 0356.421 Lucerne / Kohler K-2007 Kingston / Mansfield 2018HBNS-1 Grande Isle / Sloan SS-3103 wall hung vitreous china lavatory with single center faucet hole, contoured back and side splash shields, front overflow and supported with concealed arms. Outside dimension: 20" x 18". Color white. Compliant with ASME A112.19.2 for vitreous china fixtures.

Supply Fittings:

Delta 22C651 faucet with 3-1/2" single lever control, ADA compliant, ceramic cartridge, high temperature limit stop, color coded hot/cold identification, integrated volume and temperature control, single hole mount, vandal-resistant 0.5 gpm non-aerating spray outlet, cast brass body with chrome finish, two 3/8" inlet tubes, metal hold-down package, nominal 5-1/2" to 7" height with 2-3/4" outlet height above fixture flood rim. Compliant with ASME A112.18.1. Two Brass Craft / Dearborn or equal quarter turn angle valves, flexible risers, and escutcheons.

Waste Fittings:

Perforated grid strainer, chrome plated, with 1-1/4" tailpiece, 1-1/4" adjustable P-trap with cleanout and tubing drain to wall with escutcheon. Provide Josam / J.R. Smith / Mifab / Wade / Watts / Zurn floor mounted carrier with concealed arms. Mount fixture front flood rim at 34" above finished floor or as shown on architectural interior elevations.

Accessories:

Supply and waste insulation kit, Brocar Products / Plumberex / TCI Skal+Gard / Trap Wrap / Truebro Lav-Guard insulation kit, color white.

P-8 Sink – Single Bowl

Fixture:

Elkay LR-1918 Lustertone / Just SL-17519-A-GR 18 gauge type 304 stainless steel seamlessly drawn self-rimming sink with 3-hole on 4” centers punched back ledge, 3-1/2” drain opening, with bowl and faucet deck recessed 3/16” below outside rim of sink and fully sound dampened undercoating. Compliant with ASME A112.19.3. Outside dimensions: 19" x 18", bowl: 16" x 11-1/2" x 7-1/2".

Supply Fittings:

Delta 100LF-HDF / Chicago / Moen / Zurn ADA-compliant single lever 6” handle, deck mounted three-hole sink faucet, 10-1/2” deck plate, chrome plated, ceramic cartridge with high temperature limit stop, 9” tubular swing spout, metal hold-down package, 3/8” inlets, color coded hot/cold identification, vandal resistant 1.5 gpm aerator, integrated volume and temperature control. Compliant with ASME A112.18.1. Two Brass Craft / Dearborn or equal quarter turn angle valves, flexible risers, and escutcheons.

Waste Fittings:

Elkay LK-35 / Just J-35 stainless steel strainer with gasketed basket, 1-1/2" tailpiece, 1-1/2" adjustable P-trap with cleanout and tubing drain to wall and escutcheon.

P-9 Drainage Utility Box

Sioux Chief 696-3 and 696-1F single frame drainage box, color white. Provide 2" waste standpipe and 2" P-trap. Provide fire rated box (696R3) if unit is located in a rated wall.

P-10 Water Outlet Utility Box

Fixture:

Sioux Chief 696 series 3/8” water outlet box with 1/2" inlet, 1/2" quarter turn ball valve, mini-rester water hammer arrestor, ABS back box and frame, color white, and metal support bracket. Arrestors shall be certified to ASSE 1010 and shall be UPC listed. Valves shall meet ASME A112.18.1.

END OF SECTION 22 40 00

SECTION 22 63 13
GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Oxygen piping and pipeline components, designated "medical oxygen."
   2. Medical gas manifolds.
   3. Gas cylinder restraints.

1.02 DEFINITIONS

A. Medical gas piping systems include medical oxygen for healthcare facility patient care.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated.

1.04 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
   1. For medical gas piping specialties to include in operation and maintenance manuals.

B. Submit field quality control reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Medical Gas Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers. Upon request, submit evidence of such qualifications to the Architect.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers. Upon request, submit evidence of such qualifications to the Architect.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Medical oxygen operating at 50 to 55 psig.

2.02 PIPES, TUBES, AND FITTINGS

A. Comply with NFPA 99 for medical gas piping materials.

B. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service; or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue for Type L tube.

C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
   1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.03 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.04 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.

1. Zone-Valve Boxes:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Allied Healthcare Products Inc.; Chemetron Division.
        2) Amico Corporation.
        3) BeaconMedaes.
        4) Ohio Medical Corporation.
    b. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.[Medical air and medical vacuum tubing, valves, and gages may be incorporated in zone valve boxes for medical gases.]
        1) Interior Finish: Factory-applied white enamel.
        2) Cover Plate: Aluminum or stainless steel with frangible or removable windows.
        3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Allied Healthcare Products Inc.; Chemetron Division.
    b. Amico Corporation.
    c. BeaconMedaes.
    d. Conbraco Industries, Inc.
    e. Milwaukee Valve Co.
    f. NIBCO Inc.
    g. Ohio Medical Corporation.
2. Standard: MSS SP-110.
3. Description: Three-piece body, brass or bronze.
4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
7. Handle: Lever type, with locking device for valves not furnished in zone boxes.
8. Stem: Blowout proof with PTFE or TFE seal.
9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions or manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension for valves in zone boxes.

D. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Allied Healthcare Products Inc.; Chemetron Division.
    b. Amico Corporation.
    c. BeaconMedaes.
    d. Conbraco Industries, Inc.
    e. Ohio Medical Corporation.
2. Description: In-line pattern, bronze.
3. Pressure Rating: 300 psig minimum.
4. Operation: Spring loaded.
5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

E. Emergency Oxygen Inlet Connection: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Healthcare Products Inc.; Chemetron Division.
      b. Amico Corporation.
      c. BeaconMedaes.
      d. Ohio Medical Corporation.
   2. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
   3. Mounting:
      a. Exposed on exterior of building.
   4. Inlet: Manufacturer-installed, NPS 1, ASTM B 819, copper tubing with NPS 1 minimum ball valve.
   5. Safety Valve: Bronze-body pressure relief valve set at 75 or 80 psig.
   6. Instrumentation: Pressure gage.

F. Safety Valves:
   1. Bronze body.
   2. ASME-construction, poppet, pressure-relief type.
   3. Settings to match system requirements.

2.05 MEDICAL GAS SERVICE CONNECTIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Healthcare Products Inc.; Chemetron Division.
   2. Amico Corporation.
   3. BeaconMedaes.
   4. Ohio Medical Corporation.

B. General Requirements for Medical Gas Service Connections:
   1. The outlet style shall match the existing quick-connect style at the facility.
      a. Puritan Bennett.
      b. Chemetron.
      c. Medaes.
   2. Suitable for specific medical gas pressure and suction service listed.
   3. Include roughing-in assemblies, finishing assemblies, and cover plates.
   4. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.
   5. Recessed-type units made for concealed piping unless otherwise indicated.

C. Roughing-in Assembly:
   1. Steel outlet box for recessed mounting and concealed piping.
   2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
   3. Double seals that will prevent gas leakage.
   4. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

D. Finishing Assembly:
   1. Brass housing with primary check valve.
   2. Double seals that will prevent gas leakage.
   3. Cover plate with gas-service label.

E. Quick-Coupler Pressure Service Connections: Outlets for [carbon dioxide,] [nitrous oxide,] [and] [oxygen] with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

F. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
   1. Medical Oxygen: D.I.S.S. No. 1240.

G. Cover Plates: One piece, aluminum or stainless steel and permanent, color-coded, identifying label matching corresponding service.

2.06 MEDICAL GAS MANIFOLDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Healthcare Products Inc.; Chemetron Division.
   2. Amico Corporation.
   3. BeaconMedaes.
   4. Ohio Medical Corporation.

B. Comply with NFPA 99 for manifolds for high-pressure medical gas cylinders.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Central Control-Panel Unit:
   1. Weatherproof cabinet.
   2. Supply and delivery pressure gages.
   3. Electrical alarm-system connections and transformer.
   4. Indicator lights or devices.
   5. Manifold connection.
   6. Pressure changeover switch.
   7. Line-pressure regulator.
   8. Shutoff valves.
   9. Safety valve.

E. Manifold and Headers:
   1. Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks.
   2. Designed for 2000-psig minimum inlet pressure except nitrous oxide manifolds may be designed for 800 psig and carbon dioxide manifolds may be designed for 1500 psig.
   3. Cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1.
   4. Individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

F. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.

G. Mounting: Wall with mounting brackets for manifold control cabinet and headers.

H. Label manifold control unit with permanent label identifying medical gas type and system operating pressure in accordance with NFPA 99.

I. Medical Oxygen Manifolds: For cylinders and 55-psig line pressure and the following quantity of cylinders:.
   1. Four cylinders.

J. Medical Gas Cylinders: Furnished by Owner, after system certification testing.

2.07 GAS CYLINDER RESTRAINTS

A. For freestanding gas cylinders: Furnish eye bolts with chain restraints for upright cylinders, and provide wood blocking in wall for eye bolts.

PART 3 EXECUTION

3.01 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
   1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.

2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
    a. Scrub to ensure complete cleaning.
    b. Rinse with clean, hot water to remove cleaning solution.

3.02 PIPING INSTALLATION

A. Drawing plans and details indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss and other design considerations. Contractor shall install piping in coordination with all other trades.
B. Comply with NFPA 99 for installation of medical gas piping.
C. Install piping concealed from view unless otherwise indicated and except in equipment rooms and areas without ceilings.
D. Install piping at right angles or parallel to building walls. Install diagonal runs if specifically indicated on drawing plans.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
F. Install piping adjacent to equipment and specialties to allow service and maintenance.
G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications.
H. Install piping to permit valve servicing.
I. Install piping free of sags and bends.
J. Install fittings for changes in direction and for branch connections.
K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas equipment specified in this Section, and to service connections and equipment specified in other Sections requiring medical gas service.
L. Install medical gas service connections recessed in walls or in cabinets. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly. Mount medical gas service connections at 5’-0” above finished floor to centerline of service connection. For medical gas service connections in casework or headwall units, refer to architectural interior elevations for mounting height.
M. Install sleeves for piping penetrations of walls and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
O. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.03 VALVE INSTALLATION

A. Install shutoff valve where shown on plans and details.
B. Install check valves to maintain correct direction of gas flow from gas source equipment.
C. Install zone valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function. Mount zone valve boxes at 5’-0” above finished floor to centerline of zone valve box.
D. Install valves and gages in zone valve boxes. Rotate valves to angle that prevents closure of cover when valve handle is in closed position.
E. Install emergency oxygen inlet connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve, and with ball valve and check valve in supply main from bulk oxygen storage tank, in accordance with detail in NFPA 99.

3.04 JOINT CONSTRUCTION

A. Use only cleaned tubing and fittings for assembly.
B. Threaded Joints: Apply appropriate tape to external pipe threads.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

D. Flanged Joints: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

3.05 GAS SERVICE COMPONENT INSTALLATION

A. Install gas manifolds anchored to substrate. Coordinate electrical wiring with Division 26. Extend pressure relief valve discharge piping to safe location at building exterior.

B. Connect gas cylinders to manifold piping.

C. Install emergency oxygen inlet connection surface mounted on exterior wall in accordance with NFPA 99.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or Type 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches of each fitting and coupling.

G. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch-minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/2: 72 inches with 3/8-inch rod.
2. NPS 3/4: 84 inches with 3/8-inch rod.
3. NPS 1: 96 inches with 3/8-inch rod.
4. NPS 1-1/4: 108 inches with 3/8-inch rod.
5. NPS 1-1/2: 10 feet with 3/8-inch rod.
6. NPS 2: 11 feet with 3/8-inch rod.
7. NPS 2-1/2: 13 feet with 1/2-inch rod.
8. NPS 3: 14 feet with 1/2-inch rod.
9. NPS 4: 16 feet with 1/2-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

3.07 IDENTIFICATION

A. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99.

3.08 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas systems and to prepare test and inspection reports.

B. Tests and Inspections:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems.
2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
   a. Initial blowdown.
   b. Initial pressure test.
   c. Cross-connection test.
   d. Piping purge test.
   e. Standing pressure test for positive-pressure medical gas piping.
   f. Repair leaks and retest until no leaks exist.

3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:
    a. Standing pressure test.
    b. Individual-pressurization or pressure-differential cross-connection test.
    c. Valve test.
    d. Master and area alarm tests.
    e. Piping purge test.
    f. Piping particulate test.
    g. Piping purity test.
    h. Final tie-in test.
    i. Operational pressure test.
    j. Medical gas concentration test.
    k. Verify correct labeling of equipment and components.
    l. Verify medical gas supply sources.
4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
    a. Inspections performed.
    b. Procedures, materials, and gases used.
    c. Test methods used.
    d. Results of tests.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

D. Prepare test and inspection reports.

3.09 PROTECTION

A. Retain sealing plugs in tubing, fittings, and specialties until installation.

B. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks. and piping systems. Refer to Division 01 Section “Demonstration and Training.”
    1. Required Time: 2 hours.

END OF SECTION 22 63 13

SECTION 22 64 00
MEDICAL GAS ALARMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Master alarm panels.
   2. Area alarm panels.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Include power, signal, and control wiring diagram.

1.03 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each alarm panel, for tests performed by a qualified testing agency.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
   1. For alarm panels to include in operation and maintenance manuals.

B. Submit field quality control reports. For each alarm panel, for tests performed by a qualified testing agency.
   1. For each alarm panel, for tests performed by a qualified testing agency.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Qualify Installers for air, vacuum, and gas piping systems for healthcare facilities according to ASSE Standard #6010 for medical-gas-system installers. Upon request, submit evidence of such qualifications to the Architect.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the air, vacuum, and gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel for air, vacuum, and gas piping systems for healthcare facilities according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers. Upon request, submit evidence of such qualifications to the Architect.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Gas Systems Monitored:
   1. Oxygen, designated "medical oxygen."

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Healthcare Products, Inc.; Chemetron Division.
   2. Amico Corporation.
   3. BeaconMedaes.
   4. Ohio Medical Corporation.
   5. RAMVAC (for dental equipment only).
   6. CustomAir (for dental equipment only).

B. Source Limitations: Obtain medical alarm systems and components from single manufacturer.

2.03 GENERAL REQUIREMENTS FOR ALARM PANELS

A. Description: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting:
      a. Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
   1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.

D. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Low-Pressure Operating Range: 0 to 100 psig.
   2. High-Pressure Operating Range: Up to 250 psig.

E. Carbon-Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon-monoxide level rises above 10 ppm.

F. Vacuum Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Vacuum Operating Range: 0 to 30 in. Hg.

2.04 MASTER ALARM PANELS

A. Master Alarm Panels: Separate trouble alarm signals and indicators for each system.
   1. Standards: Comply with NFPA 99 and UL 544.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. Include alarm signals when the following conditions exist:
      a. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.
   4. The master alarm shall include at least one signal from the source equipment to indicate a problem with the source equipment at this location, all local alarm signals are listed above.

2.05 AREA ALARM PANELS

A. Area Alarm Panels: Separate trouble alarm signals and indicators for each system.
   1. Standards: Comply with NFPA 99 and UL 544.
   2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. Include alarm signals when the following condition exists:
      a. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

PART 3 EXECUTION

3.01 ALARM-PANEL INSTALLATION

A. Install alarm panels in locations required by and according to NFPA 99, as shown on the drawing. Mount panel center line at 5’-0” above finished floor.

B. Wiring to the panels shall be by Division 26. Wiring between panels and sensors shall be by Division 22.

3.02 CONNECTIONS

A. For alarm panels with gases piped to them, comply with requirements for piping specified in Section 22 63 13 "Gas Piping for Laboratory and Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to alarm panels, allow space for service and maintenance.

C. Coordinate electrical connections with Division 26.

3.03 IDENTIFICATION

A. Labeling of each indicator, indicating the condition monitored according to NFPA 99..

B. Labeling of each alarm panel for its area of surveillance according to NFPA 99.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning panels and equipment.

C. Alarm panels will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.05 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.06 ADJUSTING

A. Adjust initial alarm panel pressure set points.

3.07 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain alarm panels. Refer to Division 01 Section “Demonstration and Training.”

1. Required Time: 4 hours.

END OF SECTION 22 64 00

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Transition fittings
   2. Dielectric fittings
   3. Pipe sleeves
   4. Sleeve seals
   5. Escutcheons.
   6. Grout.
   7. HVAC demolition.
   8. Equipment and system-common requirement.
   9. Painting.
   10. Concrete bases.
   11. Supports and anchorages.

1.02 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.03 SUBMITTALS

A. Welding certificates.

B. Coordination drawings.

1.04 CLOSEOUT DOCUMENTATION

A. Record Documents: Prepare record documents in accordance with the requirements in Division 1 Section "Project Record Documents." In addition to the requirements specified in Division 1, refer to specific sections for additional record documentation.

B. Maintenance Manuals: Prepare maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data". Submit copies for review by Architect/Engineer. In addition to the requirements specified in Division 1, include the following information:
   1. Descriptive summary of function, normal system operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Warranty information for all mechanical items shall be included in one tabbed section.

1.05 QUALITY ASSURANCE

A. Product and Material Origin: All materials and products shall be manufactured within the 12 months of delivery to the site. Provide factory certified verification of the date of manufacture upon request form the Engineer.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. Storage of materials and equipment shall not impede the work of other contracts.

D. Handling of equipment and products shall be according to manufacturer’s instructions and incompliance of their warranty.

E. Protect products from weather, unless the product is slated for exterior installation. If outdoor support is necessary, support products off the ground or pavement in water tight enclosures.

1.07 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for system installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for system requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.08 PRODUCT SUBSTITUTIONS

A. Equipment manufacturer’s where indicated on the drawings are the basis for design. The contractor accepts responsibility for all design implications when providing approved equipment other than the design basis.

B. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics than the basis of design may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

C. Dimensional and Weight Changes: Equipment with dimensions or weight different than the basis of design may be furnished provided such proposed equipment is approved in writing. The contractor is responsible for verifying proposed equipment maintains the design intent for access and serviceability and reserves space for future equipment where required. Cost implications to other trades are the responsibility of the contractor.

1.09 INTERPRETATION OF PLANS

A. In general, the Drawings are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural Drawings which are dimensioned. Drawings shall not take precedence over field measurements.

B. Drawings are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail of construction. All work shall be constructed from field measurements taken at the site. This shall include all rises, drops and offsets necessary to avoid structural members or equipment and materials installed by other trades. The contractor shall coordinate the ductwork and piping layout before construction. No additional costs will be allowed for piping and ductwork fabrications without field verification of available space. If it is found, before installation, that a more convenient, suitable or workable arrangement of any or all phases of construction would result by altering the arrangement indicated on the Drawings, the architect/engineer may require the contractor to change the arrangement of his work without additional cost to the owner.

C. The drawings and specifications are intended to supplement each other. Any items shown on the drawings and not mentioned in the specifications, or vice versa, shall be executed the same as if mentioned and shown.

D. The greatest quantity or more expensive work shall govern where there is a conflict noted anywhere on the drawings and/or specifications.

1.10 COORDINATION DRAWINGS

A. Review contract documents and prepare coordination drawings as an informational submittal in accordance with Division 1 requirements. Provide drawings of all areas of the project. Architectural backgrounds of the building will be made available upon request. Detailed mechanical drawings will not be made available. Facilitate coordination meetings and revise drawings as required to resolve work conflicts. Conflicts between trades or existing conditions that arise due to work not being coordinated prior to installation shall be resolved at no cost to the Owner.

B. The Division 23 contractor shall coordinate the preparation of drawings by other trades including steel, precast concrete, fire protection, lighting, plumbing, piping, and building sound systems. The Division 23 contractor shall create composite drawings showing the work of all other trades. The Division 23 contractor shall facilitate coordination meetings as scheduled and coordinated by the General Contractor or Construction Manger to review potential conflicts and propose specific solutions. Any proposed revisions to the Contract Documents shall be noted on the coordination drawings for review by the Architect and Engineer.

C. The composite drawings of all trades shall detail all structural building elements, mechanical equipment, and work of other trades. Indicate locations where space is limited for installation, access for service, and where sequencing and coordination of installations are of importance to the efficient flow of work. The composite drawings shall include at a minimum the following. Where required for clarity multiple composite drawings may have to be submitted for each area.

1. Clearances for installing and maintaining insulation.
2. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
3. Equipment connections and support details.
4. Exterior wall and foundation penetrations.
5. Fire-rated wall and floor penetrations.
6. Sizes and locations of required concrete pads and bases.
7. Valve stem movement.
8. Dimensional locations of pipe sleeves passing through floor/roof slabs.
9. Locations of wall and ceiling access panels where required for access to mechanical equipment.
10. Reflected ceiling plans to integrate installations of light fixtures, grilles, registers, and diffusers, sprinklers, communication systems, and other ceiling mounted components.
11. Both new and existing structural elements.

1.11 COST BREAKDOWN

A. Submit a cost breakdown for each claim according to General Conditions of the Contract. Include project name, location, Architect/Engineer, Contractor and date.
   1. List the cost breakdown for labor and material separately and include a total.
   2. Breakout and detail the cost according to specification sections.

1.12 UTILITY REBATES

A. Prepare and submit utility rebate application forms and supporting documentation that are applicable within the scope of this project. Coordinate submittal with the project engineer and Owner's representative.

1.13 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section "Project Record Documents." In addition to the requirements specified in Division 1, refer to specific sections for additional record documentation.

1.14 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data". Submit copies for review by Architect/Engineer. In addition to the requirements specified in Division 1, include the following information:
   1. Descriptive summary of function, normal system operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Servicing instructions and lubrication charts and schedules.
   5. Warranty information for all mechanical items shall be included in one tabbed section.

1.15 FIRE SAFETY PRECAUTIONS

A. The Contractors shall exercise extreme care to maintain and exercise adequate fire safety precautions throughout the work. This shall include providing sufficient fire fighting devices, watchmen, standby helpers or other precautions during construction, in use of temporary heat, welding, brazing, sweating, testing or other phases of work.

B. At all times, access shall be maintained for fire department trucks to the building.

C. All welding brazing, cutting and sweating operations performed in vicinity of or accessible to combustible materials shall be adequately protected to make certain that sparks or hot slag does not reach the combustible material and start a fire.

D. All glass, glazed materials and other finish, in the vicinity of welding, brazing and cutting, shall be masked by the Contractor performing the welding work.

E. When necessary to do cutting, welding, brazing, sweating and similar work in vicinity of wood, in shafts, or vicinity of any combustible material (and the combustible material cannot be removed), the materials shall be adequately protected with fire resistant blankets or similar approved coverings. In addition, a helper shall be stationed nearby with proper fire extinguishers (provided by the Contractor performing the work) to guard against sparks and fire.

F. Whenever combustible materials have been exposed to sparks, molten metal, hot slag or splatter, a person shall be kept at the place of work to make sure the smoldering fires have not been started. Whenever cutting or welding operations are carried on in a vertical pipe shaft, a person to act as a fireguard shall be employed to examine all floors below the point of cutting or welding. This fireguard shall be kept on duty after completion of work to guard against fires and shall examine each level after this time, prior to leaving. There shall be no exceptions to this requirement and failure to comply will be construed as negligence.

1.16 PERSONAL SAFETY REQUIREMENTS

A. The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions required in connection with his work, including regulations of the Occupational Safety and Health Administration (OSHA) and other governing agencies.

1.17 TESTING, ADJUSTING AND BALANCING

A. Refer to specification section "Testing, Adjusting, and Balancing" to verify if Testing, Adjusting, and Balancing is by Owner or this Contractor. The scope of the testing and balancing work may include functional performance testing of all mechanical systems. Deficiency reports will be distributed directly to the contractor on an ongoing basis. Exceptions taken to specific direction issued by the testing agency shall be brought to the attention of the engineer by the installing contractor.

B. The Contractor shall be certain that all systems are ready for proper operation prior to balancing and adjusting with clean filter and other system elements, e.g., coils. Temperature control calibration, electrical interface, etc., shall also be complete prior to balancing and adjusting. All equipment shall be freshly oiled. The Contractor shall instruct his employees and subcontractors to leave all balancing devices in a wide open position and free all operating arms and adjustments so that they can be easily operated. The contractor shall write a letter to the testing agency indicating that each of the areas defined by the construction schedule is complete and ready for balancing.

C. The Contractor shall provide copies of all submittals for air handling and hydronic equipment to the Balancing Contractor prior to starting balancing.

1.18 COMMISSIONING

A. Refer to specification section 01 91 13 “General Commissioning Requirements” for commissioning work scope and roles and responsibilities. Include the costs of all commissioning activities in the contract price. No additional costs will be allowed. All commissioning activities shall be included in the project schedule.

1.19 FIRE, SMOKE, AND FIRE/SMOKE DAMPER COMMISSIONING

A. A.Fire, smoke, and combination fire/smoke damper commissioning is in its entirety the responsibility of the DIV 23 contractor and is not included in the third-party commissioning work scope. The DIV 23 contractor shall engage the DIV 28 contractor as a sub-contractor to complete all testing requirements. All testing and corrective measures as may be required, shall be complete prior to the start of test and balancing activities.

B. Existing Dampers:

1. Existing systems that are modified may include existing fire, smoke, and/or combination fire/smoke dampers. Field verify existing duct pathways to determine locations and all existing fire, smoke, and combination fire/smoke dampers. All locations may not be shown on the construction documents.
2. Test the operation of each damper. If deficient operation are determined and submit a report to the engineer to include corrective action recommendations.
3. Retest all dampers as may be required until each damper is proven to meet the functional intent.

C. New Dampers:

1. Functionally test the operation of all new fire, smoke, and combination fire/smoke dampers. Activation of smoke detection devices associated with each smoke damper shall be used as the method to verify smoke damper operation.
2. Operational deficiencies shall be corrected. Retest all dampers as may be required until each damper is proven to meet the functional intent.

D. Commissioning Report:

1. Submit a report to document all testing activities to include at a minimum the following:
   a. Testing representatives
   b. Schedule of all site activities
   c. List of all dampers with unique identifiers correlated to the drawings included in the report
   d. Completed corrective actions (if required)
   e. Pass date for each damper
   f. Drawing to identify all fire, smoke, and combination fire/smoke damper locations, designations (F,S, or F/S), and unique identifiers correlated to the report activities.

1.20 TEMPORARY HEAT/EQUIPMENT OPERATION

A. Provide temporary gas meter and connections to equipment provided by the General Contractor as required for temporary heat.

B. Warranties:

1. The Contractor shall provide extended warranties for all equipment and mechanical system components operated prior to the date of substantial completion. The Contractor shall obtain in writing from the manufacturer extended warranties for all equipment such that the Owner's warranty starts at the date of substantial completion in accordance with the General Division 1 requirements. Any additional costs shall be the burden of the Contractor.

C. Temporary Air Handling Equipment Operation:

1. Manually operate air-handling systems to provide suitable environment for installation of interior finishes. Provide factory start-up of all variable speed drives. Perform commissioning operations prior to starting units and operate the systems in accordance with the following procedures for manually operating the air handling systems. The Contractor shall obtain in writing from the manufacturer extended warranties for all affected equipment. Any additional costs shall be the burden of the Contractor:

a. The air handling systems shall not be operated at outside air temperature below 40.0 degrees. Open outdoor air dampers, close return air dampers, open all air terminals to full open, install filters, ensure condensate drain is functioning and electrical protection devices are installed. Start fan, monitor indoor and outdoor conditions, and operate heating and cooling systems to control space conditions; shut down systems completely and close outdoor air dampers at end of each workday. Return/exhaust fans shall not run during temporary operation.

D. Temporary Condensing Unit Operations:

1. The condensing units may be used for maintaining a suitable environment for the installation of interior finishes. The condensing unit installation must be complete in accordance with all manufacturer guidelines. Provide start-up services by an authorized factory representative. The contractor shall obtain in writing from the manufacturer extended warranties for all affected equipment. Any additional costs shall be the burden of the contractor.

1.21 PERMITS, LICENSES AND FEES

A. The Contractor shall secure all permits and licenses, both temporary and permanent required for their work. The Contractor shall pay all fees and expenses required for the permits and licenses.

1. The Contractor shall make all arrangements with each utility company and pay all service charges associated with new services or modifications to existing services.
2. The Contractor shall request inspections as required by regulating agencies and/or regulations. The Contractor shall pay all charges for inspections.
3. Contractor shall furnish the Owner with a certificate of final inspection and approval by enforcement authorities.
4. Comply with requirements of Division 00.

1.22 CORRECTIVE PERIOD / GUARANTEE

A. The Contractor shall guarantee and maintain the stability of work and materials and keep same in perfect repair and condition for the period of one (1) year after the Date of Substantial Completion of the Project.

B. Defects of any kind due to faulty work or materials appearing during the above mentioned period must be immediately made good by the Contractor at his own expense to the entire satisfaction of the Owner and Architect and Engineer Such reconstruction and repairs shall include damage to the finish or the building resulting from the original defect or repairs thereto.

C. The guarantee shall not apply to injuries occurring after final acceptance and due to wind, fire, violence, abuse or carelessness or other Contractors or their employees of the agents of the Owner.

D. This guarantee shall not apply where other guarantees for different lengths of time are specifically called for.

PART 2 PRODUCTS

2.01 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Plastic-to-Metal Transition Fittings: One-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

D. Plastic-to-Metal Transition Unions: MSS SP-107, four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.02 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 300 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.03 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.04 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.05 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening. Provide brass material with polished chrome plated finish.

2.06 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, drain, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. Lead Containing Materials: The existing building may contain lead-containing materials, including lead paint. It is the Contractor’s responsibility to meet all governmental regulations when dealing with the disposing of lead containing materials.

E. Remove from building site debris, rubbish, fluids, and other materials resulting from demolition operations. Transport and legally dispose of offsite.
   1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
   2. Burning of removed materials is not permitted on project site.

3.02 EQUIPMENT AND SYSTEM INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Install transition fittings where necessary to accommodate installed materials of construction.

F. Install dielectric fittings at all metallic joints of dissimilar metal.

G. Install chrome plated brass escutcheons for penetrations of walls ceilings, and floors that are not concealed above a ceiling.

3.03 PIPE SLEEVE INSTALLATION

A. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. For pipes penetrating gypsum-board partitions: Schedule 40 steel pipe sleeves or steel sheet sleeves.
      b. For all penetrations other than gypsum board partitions: Cast iron sleeves or Schedule 40 steel sleeves.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Flashing" for flashing.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Sealants and Caulking" for materials and installation.

B. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

C. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Firestopping" for materials.

E. Verify final equipment locations for roughing-in.

F. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.04 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.05 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.06 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
C. Field Welding: Comply with AWS D1.1.

3.07 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
C. Attach to substrates as required to support applied loads.

3.08 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

END OF SECTION 23 05 00

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 QUALITY ASSURANCE

A. Manufacturer Qualifications: Companies specializing in the manufacturer of electric motors for HVAC systems.
B. Comply with applicable electrical code and local energy code standards.
C. Equipment requiring and electrical connection shall be listed and classified by Underwriters Laboratory, Inc.

1.03 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

1.04 DELIVERY STORAGE AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering.

PART 2 PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.
C. Comply with IEEE 841 for severe-duty motors.
D. All motors driven by a variable frequency PWM drive shall include a factory-mounted, maintenance free, circumferential, conductive micro fiber AEGIS SGR Bearing Protection Ring to discharge shaft currents to ground.

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
C. Service Factor: Provide motors with the following minimum service factors.

NEMA OPEN MOTOR SERVICE FACTORS

SIZE	RPM			
HP	**3600**	**1800**	**1200**	**900**
1/6 TO 1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.25	1.15	1.15
1 1/2 TO 150	1.15	1.15	1.15	1.15

2.03 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Premium efficient, as defined in NEMA MG 1.
C. Multispeed Motors: Separate winding for each speed.
D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. Sleeve type bearings permitted for fractional hp (less than ½ hp) light duty applications.
F. Temperature Rise: Match insulation rating.
G. Insulation: Class F.
H. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Shaft Grounding: Provide integral shaft grounding as manufactured by Aegis.
C. Efficiency: Motor efficiency shall meet, at a minimum, the efficiency requirements of the most current NEMA premium efficiency standard. Motors shall be tested in accordance with IEEE Standard 112, test method B. Motor efficiencies are based upon the NEMA MGI-1987, Table 12-6B (as referenced in the State Energy Code) plus 2.5%.

MINIMUM MOTOR EFFICIENCY TABLE

	Open Motors				Enclosed Motors			
HP	3,600	1,800	1,200	900	3,600	1,800	1,200	900
1	77.0	85.5	82.5	74.0	77.0	85.5	82.5	74.0
1.5	84.0	86.5	86.5	75.5	84.0	86.5	87.5	77.0
2	85.5	86.5	87.5	85.5	85.5	86.5	88.5	82.5
3	85.5	89.5	88.5	86.5	86.5	89.5	89.5	84.0
5	86.5	89.5	89.5	87.5	88.5	89.5	89.5	85.5
7.5	88.5	91.0	90.2	88.5	89.5	91.7	91.0	85.5
10	89.5	91.7	91.7	89.5	90.2	91.7	91.0	88.5
15	90.2	93.0	91.7	89.5	91.0	92.4	91.7	88.5
20	91.0	93.0	92.4	90.2	91.0	93.0	91.7	89.5
25	91.7	93.6	93.0	90.2	91.7	93.6	93.0	89.5
30	91.7	94.1	93.6	91.0	91.7	93.6	93.0	91.0
40	92.4	94.1	94.1	91.0	92.4	94.1	94.1	91.0
50	93.0	94.5	94.1	91.7	93.0	94.5	94.1	91.7
60	93.6	95.0	94.5	92.4	93.6	95.0	94.5	91.7
75	93.6	95.0	94.5	93.6	93.6	95.4	94.5	93.0
100	93.6	95.4	95.0	93.6	94.1	95.4	95.0	93.0
125	94.1	95.4	95.0	93.6	95.0	95.4	95.0	93.6
150	94.1	95.8	95.4	93.6	95.0	95.8	95.8	93.6
200	95.0	95.8	95.4	93.6	95.4	96.2	95.8	94.1

2.05 SINGLE-PHASE MOTORS

A. Motors equal to 1/12 HP or greater and less than 1 HP be a minimum 70% efficient and be one of the following, to suit starting torque and requirements of specific motor application. Provide electronically commutated motors (ECM) where indicated on the drawings.
   1. Permanent-split capacitor.
   2. Split phase.
   3. Electrically Commuted (ECM).

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type or ECM (where noted on the drawings).

C. Electrically Commuted Motors (ECM): Shall be provided with integral variable speed control capable of accepting a variable analogue signal from the Building Automation System.

D. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

E. Motors 1/20 HP and Smaller: Shaded-pole type.

F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION, GENERAL

3.01 INSTALLATION, GENERAL

A. Install motor and equipment associated with the mechanical installation, including items furnished by others.

B. Check line voltage and phase and ensure agreement with nameplate. Notify the engineer of any discrepancies.

C. Provide electrical requirements for equipment installation, connection, and control. Refer to Division 26 for exceptions.

3.02 POWER FACTOR CORRECTION

A. Power factor correction shall be installed on all motors ½ horsepower or larger to correct motor power factor to 95 percent or greater. Power factor correction is not required for motors installed with variable speed drives or packaged rooftop or condensing units with multiple motors.

B. If factory mounting is not an equipment option, then provide required correction devices and field install. Field installation shall be done in accordance with manufacturer’s guidelines. The costs for field installation shall be included in the mechanical contractor’s scope of work.

END OF SECTION 23 05 13

SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Thermometers.
   2. Gages.
   3. Test plugs.

1.02 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.
B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated; include manufacturer's number, operating range, total range, and intended use.

1.04 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Case: Die-cast aluminum or brass, 7 inches long.
B. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.
C. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
D. Window: Glass.
E. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
F. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
G. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.02 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Liquid-filled type, drawn steel or cast aluminum diameter.
B. Element: Bourdon tube or other type of pressure element.
C. Movement: Mechanical, connecting element and pointer.
D. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
E. Pointer: Red metal.
F. Window: Glass.
G. Ring: Brass in unfinished areas including mechanical rooms. Stainless steel in finished areas.
H. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
I. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.
J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.03 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.
B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.
C. Provide heat-transfer medium with the thermowell consisting of a mixture of graphite and glycerin.

2.04 PRESSURE GAGES

A. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
   1. Case: Dry type, drawn steel or cast aluminum. Provide 2" diameter for fuel oil systems. 4" diameter for all other systems.

2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Glass.
8. Ring: Brass in unfinished areas including mechanical rooms. Stainless steel in finished areas.
9. Accuracy: Grade B, plus or minus 2 percent of middle half.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.

B. Pressure-Gage Fittings:
1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.05 PRESSURE-TEMPERATURE TEST PLUGS

A. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
B. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
C. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 EXECUTION

3.01 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

B. Install dry, vapor-actuated dial thermometers at suction and discharge of each pump.
C. Provide the following temperature ranges for thermometers:
1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions

3.02 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.
B. Install dry-case-type pressure gages at suction and discharge of each pump.

3.03 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.
B. Install thermowells with shank extending a minimum of 2 inches into fluid. Tip of thermowell shall be positioned within the center one-third of the pipe bore. Where applicable, install a pipe tee or offset collar to provide proper mounting conditions for accommodating the shank length. Install thermowell in vertical position where thermometers are indicated. Fill thermowells with heat-transfer medium prior to inserting thermometer element.
C. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
E. Install needle-valve and snubber fitting in piping for each pressure gage for fluids.
F. Install test plugs in tees in piping.

3.04 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.
B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 23 05 19

SECTION 23 05 23
GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Ball valves.
   2. Butterfly valves.
   3. Check valves.
   4. Gate valves.
   5. Globe valves.

1.02 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated.

1.04 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set gate, and globe valves closed to prevent rattling.
   4. Set ball valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.
B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
C. Valve Sizes: Same as upstream piping unless otherwise indicated.
D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.

3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Bronze Valves:
1. Fabricate from dezincification resistant materials.
2. Copper alloys containing more than 15% zinc are not permitted.

2.02 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded or soldered for NPS 2” and smaller.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.03 IRON BALL VALVES

A. Class 125, Iron Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Kitz Corporation.
d. Sure Flow Equipment Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-72.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.

e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.04 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.05 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hammond Valve.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Crane Co.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.06 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Hammond Valve.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.07 BRONZE GATE VALVES

A. Class 150, NRS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kitz Corporation.
b. Milwaukee Valve Company.
c. Powell Valves.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Crane Co.
f. Hammond Valve.
g. NIBCO INC.
2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.08 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Powell Valves.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.09 BRONZE GLOBE VALVES

A. Class 150, Bronze Globe Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Powell Valves.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
    a. Standard: MSS SP-80, Type 2.
    b. CWP Rating: 300 psig.
    c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
    d. Ends: Threaded.
    e. Stem: Bronze.
    f. Disc: PTFE or TFE.
    g. Packing: Asbestos free.
    h. Handwheel: Malleable iron.

2.10 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Crane Co.
    b. Hammond Valve.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
    a. Standard: MSS SP-71, Type I.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
    c. NPS 14 to NPS 24, CWP Rating: 150 psig.
    d. Body Design: Clear or full waterway.
    e. Body Material: ASTM A 126, gray iron with bolted bonnet.
    f. Ends: Flanged.
    g. Trim: Bronze.
    h. Gasket: Asbestos free.

2.11 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Crane Co.
    b. Hammond Valve.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
    a. Standard: MSS SP-71, Type I.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
    c. NPS 14 to NPS 24, CWP Rating: 150 psig.
    d. Body Design: Clear or full waterway.
    e. Body Material: ASTM A 126, gray iron with bolted bonnet.
    f. Ends: Flanged.
    g. Trim: Bronze.
    h. Gasket: Asbestos free.
    i. Closure Control: Factory-installed, exterior lever and weight.

2.12 IRON CENTER GUIDED CHECK VALVES

A. Class 150, Iron Center Guided Compact Wafer Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Crane Co.
    b. Hammond Valve.
    c. Milwaukee Valve Company.

d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Style: Spring loaded.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Metal Seat: Bronze.

2.13 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install chainwheels on operators for ball and butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
F. Install check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem plumb and vertical.
3. Centered guided: Orient in horizontal or vertical position.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or butterfly valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service except Steam: Globe or ball valves.
   4. Throttling Service, Steam: Globe valves.
   5. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.05 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Horizontal flow, Class 150, bronze disc.
   4. Bronze Lift Check Valves: Vertical flow, Class, 150, bronze disk.
   5. Bronze Gate Valves: Class 150, NRS.
   6. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
   3. Iron Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
   4. Iron Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.
   5. Iron Swing Check Valves: Horizontal flow, Class 125, metal seats.
   6. Iron Center Guided Check Valves: Vertical flow, Class 150, bronze seat.
   7. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and weight.
   8. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125.

END OF SECTION 23 05 23

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Pipe positioning systems.
   8. Equipment supports.

1.02 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.03 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.

D. Coordinate the work with other trades to provide additional framing and materials required for installation.

E. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

F. Coordinate the arrangement of supports with ductwork, piping, equipment, and other potential conflicts installed under other sections by others.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Fiberglass pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Fiberglass strut systems. Include Product Data for components.
   4. Pipe stands. Include Product Data for components.
   5. Equipment supports.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.3, "Structural Welding Code--Sheet Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of HVAC work.

B. Select hanger and supports materials and methods appropriate for the application in accordance with the most current edition of MSS SP-58.

C. Select support and attachment methods and components in accordance with manufacture's application criteria. Include considerations for vibration, equipment, operation, and shock loads where applicable. Notify the engineer for resolution where manufacturer requirements conflict with the requirements stated here-in. The more expensive materials and methods shall be included in the contractor's bid.

D. Steel components: Use corrosion resistant materials suitable for the environment where installed.

1. Indoor Dry Locations: Zinc-plated steel unless otherwise indicated.
2. Outdoor and Damp or Wet Indoor Locations: Galvanized steel, stainless steel, or approved equivalent.
3. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
4. Galvanized Steel: Hot-dipped galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A152/A153M.

E. Dielectric barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type. Acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

2.02 TRAPEZE PIPE HANGERS

A. Description: Shop or field-fabricated support assembly made of continuous-slot metal strut channel with associated tracks, fittings, and related accessories. Provide in accordance with MSS SP-58 and NFMA-4 requirements.

2.03 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components. Provide in accordance with MSS SP-58 and NFMA-4 requirements.

B. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.04 STEEL CABLE HANGING SYSTEMS

A. Furnish hardware, fittings, and accessories from a single manufacturer.

B. Provide cable-wire in bulk or precut lengths with respective cable hangers in accordance with manufacturer requirements for intended loads.

C. Provide necessary accessory components including brackets, clips, c-clip hangers, covers, and y-hook hangers ion accordance with manufacturer recommendations.

2.05 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06 INSULATION SHIELD

A. Description: 16 gauge galvanized sheet metal formed to fit contour of pipe insulation.

B. Shield Length: Minimum 12".

2.07 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.08 FIELD FABRICATED EQUIPMENT AND PIPE SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes. All support components installed outside shall be stainless steel or hot dipped galvanized.

2.09 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

1. Installation

D. Install products in accordance with manufacture’s instructions.

E. Install anchors and fasteners in accordance with ICC evaluation services, ICC (ICC-es) evaluation report conditions of use where applicable.

F. Do not provide support from piping, ductwork, conduit, or other systems.

G. Do not provide support from suspended ceiling support system or ceiling grid.

H. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

I. Do not penetrate or otherwise notch or cut structural members without approval by the Structural Engineer.

J. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

K. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

L. Secure fasteners according to manufacturer's recommended torque settings.

M. Remove temporary supports.

3.02 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.03 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Insulation Insert Installation: Install in pipe hanger for all insulated piping 2" and larger.

E. Insulation Shield: Install insulation shields (in addition to the insulation insert where it is required) at all hanger locations for insulated piping.

F. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Roof Mounted Pipe Supports:
   1. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs. Refer to Mechanical Roof Plans for curb-mounting-type pipe stand locations. Coordinate required installation locations with the roofing contractor.
   2. Adjustable Pre-Manufactured Roof Pipe Supports: Provide roof protection pad beneath each base support in accordance with applicable roof warranty requirements. Support shall not penetrate the roofing membrane. Refer to the Mechanical Roof Plans for adjustable pre-manufactured roof pipe support locations. Provide quantity and spacing necessary for adequate pipe support. Locate supports at a minimum at each tee and change in direction.

H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

O. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above or below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      b. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
   2. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   3. Pipes NPS 8 and Larger: Include wood inserts.
   4. Insert Material: Length at least as long as protective shield.
   5. Thermal-Hanger Shields: Install with same thickness as piping insulation.

3.04 EQUIPMENT AND PIPE SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor or grade.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.05 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for [trapeze pipe hangers] [and] [equipment supports].

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.06 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to a maximum of 1-1/2 inches. Threaded rods shall be trimmed to be flush with supports in exposed areas at 7’-0” and lower.

3.07 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Duct labels.
   4. Valve tags.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Provide a listing of all equipment to be labeled with the proposed content for each label.

1.03 CLOSEOUT DOCUMENTATION

A. Record Documents: Submit record documents in accordance with the requirements in Division 1 Section "Project Record Documents."
   1. Provide as-built drawing showing all valves and corresponding valve number.
   2. Provide valve schedule.

1.04 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch or Stainless steel minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   4. Fasteners: Stainless-steel rivets or self-tapping screws.
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

E. At each VRF unit, provide a label that identifies the VRF Number. Attach to the ceiling grid beneath each VRF unit to mark its location. Font shall be Avalon, ¼" height, and red in color on a transparent background.

2.02 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.
3. Color: Provide background and lettering color in accordance with Part 3 applications.

2.03 DUCT LABELS

A. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

B. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

C. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

D. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

E. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.
3. Color: Provide background and lettering color in accordance with Part 3 applications.

2.04 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass or Stainless steel minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Provide equipment labels for each piece of equipment identified on drawing schedules.

D. At each VAV box, provide a label that identifies the VAV Box Number. Attach to the ceiling grid beneath each VAV box to mark its location. Font shall be Avalon, ¼" height, and red in color on a transparent background.

E. Provide identification at access panels to all fire, smoke, and combination fire smoke dampers.

3.03 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Heating Water Piping:
   a. Background Color: Red.
   b. Letter Color: White.
2. Refrigerant Piping:
   a. Background Color: Black.
   b. Letter Color: White.

3.04 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Supply, Return, and Mixed air:
   a. Background Color: Green
   b. Letter Color: White
2. Exhaust and Relief Air:
   a. Background Color: Red
   b. Letter Color: White
3. Outside Air:
   a. Background Color: Blue
   b. Letter Color: White
4. Hazardous Materials:
   a. Background Color: Brown
   b. Letter Color: White

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.05 VALVE-TAG INSTALLATION

A. Install tags on main and branch line shut off valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves at equipment; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Refrigerant: 1-1/2 inches, round.
      b. Hot Water: 1-1/2 inches, round.
   2. Valve-Tag Color:
      a. Refrigerant: Natural.
      b. Hot Water: Natural.
   3. Letter Color:
      a. Refrigerant: Black.
      b. Hot Water: Black.

END OF SECTION 23 05 53

SECTION 23 07 00
HVAC INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Insulation materials and accessories.
   2. Fire-rated insulation systems.
   3. Jacketing and accessories.
   4. Weather barrier coatings.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any). Provide shop drawings detailing application of protective shields; saddles; inserts; covering of heat tracing; application at pipe expansion joints; application elbows, fittings, flanges, valves, and specialties; removable insulation at specialties, equipment connections, and access panels; application of field-applied jackets; application at linkages of control devices; and field application for each equipment type.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in applying insulation materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance. Installer shall meet, at a minimum, all requirements listed below. Upon request, submit evidence of such qualifications to the Architect.
   1. Company specializing in performing work of this section with minimum three years documented experience, minimum three successfully completed projects of similar scope and complexity, and approved by manufacturer.
   2. Designate one individual as project foreman who shall be on site at all times during installation.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.05 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.06 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric (FE): Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials; thermal conductivity (avg) of 0.25 Btu/hr-ft2-°F or lower at mean temperature of 75°F; 3.0 lbs./ft3 density (ASTM D1622); 0.08 perm-in permeability (ASTM E96); 0.2% water absorption (ASTM C209).

G. Mineral-Fiber Blanket Insulation (MF): Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I; thermal conductivity (avg) of 0.27 Btu/hr-ft2-°F or lower at mean temperature of 75°F. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Refer to Part 3 below for insulation density.

H. Rigid Fiberglass Board Ductwork Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type 1, 3.0 lb./cu. ft. density for up to 450°F. Service shall meet or exceed ASTM C 680 thermal conductivity test of .23 BTU-in/hr-ft2 - °F at 75°F mean temperature. Provide with factory applied FSK jacket.

I. Mineral-Fiber, Preformed Pipe Insulation (MF): Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL; thermal conductivity (avg) of 0.25 Btu/hr-ft2-°F or lower at mean temperature of 75°F. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

J. Mineral-Fiber, Pipe and Tank Insulation (MF): Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 3.5 lb/cu. ft.or more. Thermal conductivity (k-value) at 100°F is 0.29 Btu/hr-ft2-°F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Mineral Wool Pre-formed Pipe and Blanket: Inorganic fibers from basalt with thermosetting resin binder and 1,200°F temperature rating. Conform to ASTM C447, C547, C85, and ASTM E84. Provide with ASJ jacket. Thermal conductivity of 0.73 BTU/hr-ft2-°F at 700°F.

2.02 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 200 deg F.
   3. Solids Content: 63 percent by volume and 73 percent by weight.
   4. Color: White.

2.05 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
   2. Service Temperature Range: Minus 50 to plus 180 deg F.
   3. Color: White.

2.06 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: White.

2.07 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I, for applications where the systems operate below ambient temperature at least part of the time or where a vapor barrier is required.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I, for applications where the systems operate below ambient temperature at least part of the time or where a vapor barrier is required.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Vapor retarder shall be rated for 150°F service, ASTM E 96 vapor permeance rated at 0.02 perms., for applications where systems operate above ambient temperatures or where a vapor retarder is not required.

2.08 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, as follows:
   1. Shall comply with ASTM C921, Type I, for applications where the systems operate below ambient temperature at least part of the time or where a vapor barrier is required.
   2. Shall comply with ASTM C921, Type II, for applications where systems operate above ambient temperatures or where a vapor retarder is not required.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: White.
   3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   4. Factory-fabricated tank heads and tank side panels.

C. Fitting Covers:
   1. PVC Jacket: One or two piece pre-molded high impact PVC fitting covers with fiberglass inserts and accessories. Covers shall be UV resistant and comply with ASTM 1784-92. Covers shall be sized to comply with insulation applications detailed in Part 3.0.
      a. Below ambient systems: provide continuous vapor barrier in accordance with manufacturer recommendations.
      b. Fiberglass Inserts: Thermal conductivity (ASTM C177), thermal conductivity average of 0.26 Btu/hr-ft2-˚F or lower at a mean temperature of 75 ˚F.

D. Metal Jacket:
   1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Outdoor Applications: 2.5-mil- thick Polysurlyn.
      d. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
         8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.09 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches.
   2. Thickness: 3.7 mils.

3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch wide with wing seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch wide with wing seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.
5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.11 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 PIPING INSULATION APPLICATION

A. Piping System Insulation: Insulate with insulation types and thicknesses as listed in the table below. If more than one pipe material is listed for a piping system, selection from materials listed is the contractor's option.

TABLE NO. 23 07 00: MINIMUM PIPE INSULATION

			Insulation Thickness in Inches for Pipe Sizes				
Piping System Types	**Fluid Temp Range, °F**	**Type of Insulation (1)**	**3/4" and Smaller**	**1" to 1 ¼"**	**1 ½" to 3"**	**4" to 6"**	**8" and Larger**
Conditioned Spaces							
Hot Water (7)	105-200	MF	1½"	1½"	2"	2"	2"
Make-Up Water	Any	MF, FE	½"	½"	1"	-	-
Condensate Drains	Any	FE	½"	1"	1"	-	-
Refrigerant (Suction)	40-55	FE	½"	½"	1"	1"	-
Refrigerant (Hot Gas) (4)	Up to 140	MF	1"	1"	1½"	-	-
Unconditioned Spaces (6)							
Refrigerant (Suction)	40-55	FE	1"	1"	1½"	1½"	-

Notes:

(1) Insulation Material Abbreviations:

a. Mineral fiber (MF) – with factory applied jacket per part 2.0 requirements.

b. Flexible Elastomeric (FE)

(2) Provide flexible elastomeric cellular insulation at valves and fittings. Refer to drawings for installation details.

(3) Provide two layers of insulation for thickness 1 ½" and greater. Longitudinal seams shall be offset to ensure a continuous vapor barrier.

(4) Insulation not required outside of the building.

(5) Insulate piping indicated within 10 feet at the exterior envelope.

(6) Unconditioned spaces shall include all systems indicated located in mechanical rooms, tunnels, boiler rooms, outdoor storage rooms, and outside the building envelope.

(7) For hot water, steam and steam condensate piping only, piping smaller than 1½" and located in partitions within conditioned spaces, reduction of these thicknesses by 1" shall be permitted, but not to thicknesses below 1".

B. Refer to Division 23 Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for insulation insert and insulation shield requirements.

C. Outdoor Piping System Insulation: Increase insulation thicknesses indicated for indoor applications by ½". All outdoor insulation shall be flexible elastomeric or polyolefin. Provide with weather barrier aluminum jacket.

D. Insulation Omitted: Omit insulation for the following:

1. Hot low pressure piping within radiation enclosures or unit cabinets.
2. Cold piping within unit cabinets provided piping is located over drain pan.

3.04 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply, outdoor, and combustion air.

2. Indoor, exposed supply (unless otherwise noted), outdoor, and combustion air.
3. Indoor, exposed exhaust air leaving energy recovery equipment.
4. Indoor, exposed return located in non-conditioned space.
5. Indoor, concealed exhaust and relief (including dryer vents). Insulate in the conditioned space a minimum of 3'-0" from the building exterior and extending to 3'-0" beyond the isolation damper where a damper is present.
6. Indoor, exposed exhaust and relief (including dryer vents). Insulate in the conditioned space a minimum of 3'-0" from the building exterior and extending to 3'-0" beyond the isolation damper where a damper is present.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

B. Items Not Insulated:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1/IECC.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.05 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply-air duct and plenum insulation:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.0-lb/cu. ft nominal density.

B. Concealed, outdoor and combustion air duct and plenum insulation:
1. Mineral-Fiber Blanket: 2 inches thick and 1.0-lb/cu. ft nominal density.

C. Concealed, exhaust-air, dryer vents, and relief-air duct and plenum insulation:
1. Rigid Fiberglass Board: 3 inches thick and 3.0-lb/cu. ft nominal density.

D. Partially-exposed, supply-air duct and plenum above cloud ceiling insulation:
1. Rigid Fiberglass Board: 2 inches thick and 3.0-1b/cu.ft. nominal density.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.0-1b/cu.ft. nominal density. For round ducts only.

E. Exposed, supply-air duct and plenum insulation: Insulation not required on exposed ductwork within a conditioned space that its serves (i.e. Gym or garage). If an exposed duct passes through an area served by a different air handling unit, the duct shall be insulated. All ducts with a mechanical room, penthouse, or boiler room shall be insulated.
1. Rigid Fiberglass Board: 2 inches thick and 3.0-lb/cu. ft nominal density.

F. Exposed, return-air duct and plenum insulation, non-conditioned areas:
1. Rigid Fiberglass Board: 2 inches thick and 3.0-lb/cu. ft nominal density.

G. Exposed, outdoor and combustion air duct and plenum insulation:
1. Rigid Fiberglass Board: 2 inches thick and 3.0-lb/cu.ft. nominal density.
2. Mineral-Fiber blanket: 2 inches thick and 1.5 lb/cu.ft nominal density. For round ducts only.

H. Exposed, exhaust-air, dryer vents, and relief-air duct and plenum insulation:
1. Rigid Fiberglass Board: 3 inches thick and 3.0-lb/cu. ft nominal density.

3.06 ATTIC DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed in Contractor's option. All ductwork and plenums in attics shall be insulated to a minimum of R-12.
1. Mineral-Fiber Blanket: Single layer, 4.2 inches thick and 0.75-lbs/cu.ft. nominal density.
2. Mineral-Fiber Blanket: Two layers, each 2-inches thick and 1.0-lb/cu.ft, nominal density. Omit vapor barrier on inner layer.
3. Rigid-Fiberglass Board: 3-inches thick and 3.0-lb/cu.ft. nominal density.

3.07 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. For all insulation, seal. Exposed fiberglass including cut pre-formed pipe sections with manufacturer’s approved mastic.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above ambient services, do not install insulation to the following:

   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.

4. Manholes.
5. Handholes.
6. Cleanouts.

3.08 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in Division 07 Section "Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Pipe: Install insulation continuously through floor penetrations.
   3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Firestopping."

3.09 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
d. Do not overcompress insulation during installation.
e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.10 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Fiberglass inserts with PVC fitting covers are acceptable. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Fiberglass inserts with PVC fitting covers are acceptable. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Fiberglass inserts with PVC fitting covers are acceptable. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Fiberglass inserts with PVC fitting covers are acceptable. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

E. Provide 16 gauge galvanized sheet metal insulation shields at all hanger locations. Shields shall be a minimum of 12” in length and formed to fit pipe contour.

3.11 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.12 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.13 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

END OF SECTION 23 07 00

SECTION 23 09 00
BUILDING AUTOMATION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. General Description: Furnish a fully integrated Building Automation System utilizing intelligent distributed control modules for equipment monitoring and control. BAS is hereby defined to include, but not limited to, central computer workstation, input/output (I/O) devices, I/O interfaces, modems, housings, interconnect cabling, valves, sensors, thermostats, dampers, controllers, actuators, and control modules and other panels associated with equipment and required to provide system control functions as indicated on drawings and schedules, and by requirements of this section.
   1. The system shall be modular in nature and shall permit expansion of both capacity and function through the addition of sensors, actuators, modular control units, application specific controllers and operator devices.
   2. All control system hardware and virtual software points required to accomplish the intent of the control sequences shall be programmed conforming to ASHRAE standard 135 BACnet protocol. It is the intent that the system be programmed with BACnet interoperable objects such that it can be interfaced with other equipment at a future date.

B. Provide assistance and technical support as required to the Testing and Balancing and Functional Performance Testing Contractor to accomplish all testing work. Upon completion of the self performed tests required in Part 3.0 “Quality Control”, notify the testing agent in writing that the system is ready for testing. The notification shall include a copy of all self performed checklists. Refer to specification sections “General Commissioning Requirements” and “Testing, Adjusting, and Balancing” for additional information.

C. Access to the system, either locally in the building or off site shall be accomplished through standard web browser software via the internet and local area network.

D. Coordinate with the Owner’s representative and associated building technologies groups for the installation of a rack mounted web based server. Conform to the Building Technology requirements.

E. Provide all variable frequency motor controllers in accordance with all requirements of specification section 23 09 50 "Variable-Frequency Motor Controllers." Provide all variable-frequency controllers as indicated on the drawings and as required to accomplish all control functions required in the sequence of operations. Turn drives over to the Electrical Contractor for installation.

F. Program systems to accomplish all control functions in accordance with the requirements of Specification Section 23 09 93 "BAS Sequence of Operations."

1.02 POWER SUPPLY

A. Power supply wiring from power source to power connections on controls and/or control modules. Provide all 24 vac transformers as required for all control operations. Coordinate with the electrical contractor for the locations and quantities of available spare breakers. Review the electrical drawings prior to bid to determine power source locations and voltage. The building automation system contractor is required to provide all transformer installations as required for the available power voltage.

B. Any equipment on the emergency electrical system shall be connected to a spare breaker in an equipment branch emergency panelboard to provide uninterrupted operation. Contractor shall not utilize the life safety or critical branch of emergency power electrical work.

1.03 ELECTRICAL WORK

A. Provide the following electrical work as work of this section, complying with all Division 26 and 27 specification requirements:
   1. Control wiring between field-installed controls, indicating devices, thermostats and sensors unit control panels.
   2. Raceways, and electrical boxes and fittings: provide raceways, and electrical boxes and fittings complying with Division 26 specifications.
   3. Conduit and junction boxes for all control devices (temperature sensor, thermostats, wall switches, etc.) Shall be provided by the building automation system contractor. Route conduit from control device junction boxes in wall up to ceiling/plenum spaces. All wiring in outdoors and in mechanical rooms, electrical rooms, air-handling air streams and similar spaces shall be completely in conduit.

4. The temperature control contractor shall provide relays as required for starters of all 120/1-volt equipment not furnished with factory starters, or if starters are not furnished by the electrical contractor. Control relays shall be provided in NEMA 1 enclosure.
5. All conduit in spaces other than mechanical rooms, boiler rooms, and electrical rooms that is not routed above the ceiling shall be concealed in walls. It is the responsibility of the building automation system contractor to coordinate conduit required to be installed in poured concrete walls prior to construction
6. BAS communications networks shall comply with requirements of Division 26 and 27 specifications. BAS communication network cabling shall be installed by the BAS contractor. Cabling pathways and supports shall be independent of other building systems. Use of pathways and supports provided by another contractor is not acceptable.

1.04 QUALITY ASSURANCE

A. Contractors shall have a minimum ten years of experience installing and programming control systems. Contractors shall also be factory authorized representative for the control product installed. Submit proof of years of experience and factory authorization upon request.
B. NEC Compliance: Comply with applicable requirements of NEC pertaining to installation of Building Automation Systems, including, but not limited to, remote-control, signaling and power-limited circuits.
C. UL Compliance: Provide Building Automation System components and ancillary equipment which are listed and labeled in accordance with UL 864 and UL 916.
D. NEMA Compliance: Comply with NEMA'S Pub No. 250, and Stds ICS 1, 2, 3 and 6 pertaining to enclosures and controls for Building Automation Systems.
E. FCC Compliance: Comply with Subpart J of Part 15, Federal Communications Commission Rules, pertaining to Class A radiation and computing devices and low power communication equipment operating in commercial type environment. Comply with Part 68, Federal Communication Commission Rules, pertaining to labeling of telephone equipment, including data sets and modems, indicating FCC registration and numbering.
F. EIA Compliance: Comply with Electronic Industries Association's Std RS-232 pertaining to interfacing requirements for connecting data terminals and communication equipment.
G. IEEE Compliance: Comply with IEEE Std 488, "Standard Digital Interface for Programmable Instrumentation", for interfacing instrumentation into system.
H. ANSI Compliance: Comply with ANSI X3.4, "Code for Information Interchange", requirements for interfacing computer data processing with communication terminal equipment.
I. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to electronic controls and control sequences.
J. ASHRAE 135 Compliance: Comply with most recent version of ASHRAE 135-BACnet: A Data Communication Protocol for Building Automation and Control Networks.

1.05 RELATED WORK

A. Refer to other Division 23 sections for the installation of instrument wells, valve bodies, sensors, flow switches, smoke detectors, and dampers. Coordinate equipment delivery schedules and installation requirements.

1.06 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each control device furnished, dampers, valves, sensors, thermostats, etc. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-up instructions. Indicate system power connections to electrical power feeders.
B. Shop Drawings
    1. Provide system architecture lay out showing field panels, Application Specific Controllers (ASC), central computer terminal, required network hardware, horizontal and backbone network cabling, tie-in to existing systems, and power panels (see system layout for system requirements).
    2. Provide panel numbering sequence and ASC’s submittal showing specific units controlled by each piece of DDC hardware.
    3. Provide point address, set points, alarm limits, wire types, conduit knock out diagrams and wiring diagrams for all points of interface.

4. Provide power panel layouts showing number and type of transformers and termination strips. Panels must meet UL listing requirements.
5. Provide technical cut sheets for DDC hardware and sensors.
6. Submit drawings for each system automatically controlled, containing the following information:
    a. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, sensors and control devices. List all equipment associated with each system, no general references will be accepted. Include damper and valve failure positions.
    b. Label each control device with setting or adjustable range of control.
    c. Indicate factory and field wiring.
    d. Indicate each control panel required, with internal and external piping and wiring clearly indicated. Provide detail of panel face, including controls, instruments, and labeling. Include verbal description of sequence of operation.

C. User Interface Graphics: Submit for review all user interface graphics prior to substantial completion of the project. The Owner reserves the right to modify system graphics prior to final payment.

D. Wiring Diagrams: Submit power, signal and control wiring diagrams, breaker location and identification, transformer locations, and communication link locations indicating panel-to-panel connections, for Building Automation Systems. Clearly differentiate between portions of wiring that are manufacturer- installed and portions that are field-installed.

E. Samples: Submit samples of each type of thermostat/temperature sensor, in accordance with requirements of Division 1.

1.07 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".

B. Record Documents: Submit record documents in accordance with the requirements in Division 1 Section "Project Record Documents."
1. Provide as-built documents at the conclusion of the project to include the following:
    a. Thumb drive of all program code.
    b. The original source code shall be on the server.
    c. Floor plans indicating the locations of all system controllers and all network connections.

C. Warranty: Submit special warranty specified in this Section.

D. Submit field quality control reports.

E. Agreement to Maintain: Prior to time of final acceptance, installer shall submit agreement for continued service and maintenance of Building Automation Systems, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, and software maintenance for one-year period commencing after the warranty period required by the terms of this contract. the Owner’s representative shall retain the option for annual renewal of the offered service agreement.

1.08 DELIVERY, STORAGE AND HANDLING

A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protected from weather.

1.09 WARRANTY

A. Provide a special warranty to maintain the stability of work and materials and keep same in perfect repair and condition for a minimum of two (2) years. The warranty shall be for one (1) year in addition to the one year required by the terms in the front end of these contract documents.

B. Correct defects of any kind immediately and at Contractor’s expense, due to faulty work or materials appearing during the above mentioned period and made to the entire satisfaction of the Owner and Architect/Engineer. Such reconstruction and repairs shall include damage to the finish or the building resulting from the original defect or repairs thereto.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering Building Automation Systems which may be incorporated in the work include the following:
1. Automated Logic

2.02 BUILDING AUTOMATION SYSTEM – HARDWARE

A. General: Provide Building Automation Systems with adequate capacity and performance rating to process the number of system points indicated. Comply with manufacturer's standard design, materials, and components; construct in accordance with published product information, as required for complete installation, and as herein specified.

1. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate both the ASHRAE Standard 135 BACnet communication protocols an open, interoperable system.
2. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ASHRAE™ Standard 135, BACnet to assure interoperability between all system components is required. For each BACnet device, the device must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet.
3. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
4. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Data Base Connectivity (ODBC) or Structured Query Language (SWL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
5. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's network system. Systems employing a "flat" single tiered architecture shall not be acceptable.
    a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
    b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.
6. Control modules shall be capable of proper operation in an ambient environment of 32°F to 120°F and 10% to 90% relative humidity--non-condensing.

B. Operator User Interface Hardware: Computers and other hardware devices for access by the building operator to the web-based user interface will be provided by the Owner. Coordinate with the Owner/IT team to present interface options and determine hardware requirements.

C. Control Networks

1. Building Automation System Network:
    a. Provide a microprocessor-based communications data path which shall act as a "peer-to-peer" network allowing all control modules to communicate with equal authority. Provide all network switches, cabling, and devices to achieve the performance requirements herein.
    b. The network switch devices shall be managed and provide full-duplex communication. The switch packet routing algorithm shall minimize bandwidth consumption. Network hubs or unmanaged switches will not be acceptable.
    c. The BAS network shall be responsible for routing global information from the various control module networks.
    d. The BAS Network shall be a 1 Gigabit/Sec Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local host computer system.

e. BAS network minimum physical and media access requirements:
    1) Ethernet; IEEE standard 802.3
        (a) Cable; 10 Base-T, UTP-8 wire, Plenum Rated (Type CMP). Conform to Category 6 requirements. Other Category requirements may be provided to match existing conditions upon request an only with written approval from the engineer.
    2) Minimum throughput; 1 Gbps with backwards compatibility with 10/100 networks.
f. Provide a connection to the Owner's LAN/WAN at a single point at a location determined by the Owner. All costs associated with extending the network to the point of connection is the responsibility of the contractor. Multiple connections to Owner's network equipment are prohibited.
g. The local host computer, if specified, shall not serve as the connection point of the BAS network to the Owner's LAN.

2. Application Specific Controller (ASC) Network
    a. ASC Controllers shall be used for direct digital control of selected single zone equipment. They shall be microprocessor based. In the event of loss of communication with the network, the controller shall function in a stand-alone mode, with all control sequences and schedules performed. Provide user-defined default algorithms (values) for global points affecting the operation of the ASC, such as outside lights levels, outside temperatures, status of heating system, etc.

D. Network Area Controller (NAC)
1. Provide one or more Network Area Controllers (NAC) as required to interface between the Building Automation Network and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. NAC controllers shall present data in accordance with BACnet ASHRAE Standard 135. It shall be capable of executing application control programs to provide:
    a. Calendar functions
    b. Scheduling
    c. Trending
    d. Alarm monitoring and routing
    e. Time synchronization
    f. Integration BACnet controller data.
2. The Network Area Controller must provide the following hardware features as a minimum:
    a. One Ethernet Port -10 / 100 Mbps
    b. One RS-232 port
    c. Battery Backup
    d. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
    e. The NAC must be capable of operation over a temperature range of 0 to 55°C
    f. The NAC must be capable of withstanding storage temperatures of between 0 and 70°C
    g. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing
3. The NAC shall provide multiple user access to the system. A database resident on the NAC shall provide a data access mechanism to read and write data stored within it.
4. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
5. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
6. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network. Provide at a minimum eight alarm classes for the purpose of routing types.
7. Alarm data recorded for each alarm shall include the time and date, location, equipment, acknowledge time and date, number of occurrences since last acknowledgement.
8. The NAC shall have the ability to collect data for any property of any object and store this data for future use.

9. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
10. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached it's user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server.
11. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
12. Each (NAC) shall be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, A to D conversion, clock/calendar and voltage transient protection. All volatile memory shall have a battery backup.
13. All point data, algorithms and application software within an (NAC) network shall be modifiable from the Central workstation. It shall not be necessary to enter parameters at the (NAC) for control and programs to operate.
14. Each (NAC) shall execute application programs, calculations, and commands via a microcomputer resident in the (NAC). The database and all application programs for each (NAC) shall be stored in read/write non-volatile memory within the (NAC) and shall be able to upload/download to or from the Central Site.
15. Each (NAC) shall be connected to the BAS network for communicating to/from other Control modules. Each (NAC) shall include self-test diagnostics which allow the (NAC) to automatically relay any malfunctions of alarm conditions that exceed desired parameters as determined by programming input to the network.
16. Each (NAC) shall contain both software and hardware to perform full DDC/PID control loops.

E. Database Backup and Storage
1. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on an user-defined time interval.
2. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
3. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

F. Existing Web Server: Extend new system from the existing web server. Verify the capacity and configuration and notify the engineer if system modifications are required.

G. Application Specific Control Modules (ASC)
1. Provide one of the following ASC's:
   a. ASC Modules shall be microprocessor based Interoperable Controllers that shall communicate in BACnet ASHRAE Standard 135 open protocol. ASC's shall be capable of providing the direct digital control of single zone Terminal HVAC Units, Unit Ventilators, Fan Coils, Heat Pumps, Variable Air Volume (VAV) Terminals and other applications as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier must provide a PICS document showing the installed systems compliance level to the ASHRAE Standard 135. Minimum compliance is Level 3.
2. The ASC's shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
3. The ASC Sensor shall connect directly to the ASC and shall not utilize any of the I/O points of the controller. The ASC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The ASC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the ASC controller is connected. The ASC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
4. All ASC's shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

5. All control applications shall be field-selectable such that a single controller may be used in conjunction with any of the above types of terminal units.
6. Each ASC shall communicate with equal authority on a "peer-to-peer" basis.
7. Each ASC shall execute application programs, calculations, and commands via a microcomputer resident in the ASC. The database and all application programs for each ASC shall be stored in read/writable non-volatile memory. All volatile memory shall have a battery backup.
8. Each ASC shall contain both software and hardware to perform full DDC/PID control loops. ASC shall be able to provide analog output, in addition to normal binary type output.
9. Control modules shall include all point inputs and outputs necessary to perform the specified control sequences. As a minimum, 50% of the point outputs shall be of the Universal type. Analog outputs shall be industry standard signals (e.g. 24V floating control) allowing for interface to a variety of modulating actuators.
10. The control modules shall be powered from a 24 VAC source and shall function normally under an operating range of 18 to 28 VAC(-25% to +17%), allowing for power source fluctuations and voltage drops. Provide each module with a suitable cover or enclosure to protect the intelligence board assembly.
11. Each ASC shall have LED indication for visual status of communication, power, and all outputs.
12. Each controller shall include provisions for manual and automatic calibration of associated transducers in order to maintain stability and control drift over time.
13. The module shall interface to a variety of matching electronic room temperature sensors of the RTD or thermistor type with the following characteristics:
    a. Independent setpoint modes for heating, cooling, and Night Setback.
    b. Tamperproof locking cover.
    c. Allow installation up to 100 ft from controller.
14. Controller points and set points shall be accessible from the central workstation and from a plug in jack at the base of each controller's sensor.
15. Contractor shall field verify operation of all controllers to insure correct field wiring, test actuator stroke, and correlate with controller submittal.
16. Contractor shall provide a POT and instructions to the balancer to read and adjust system perimeters for the balancing report.

H. Interoperable BACnet Controller (IBC)
1. Controls shall be microprocessor based Interoperable Controllers that shall communicate in the BACnet ASHRAE Standard 135 open protocol. IBCs shall be provided for each Variable Air Volume (VAV) Terminals and other applications as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. the system supplier shall provide a PICS document upon request from the Engineer showing the installed systems compliance level to the ASHRAE Standard 135. Minimum compliance is Level 3.
2. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
3. The IBC Sensor shall connect directly to the IBC and shall not utilize any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
4. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IBC shall be stored in a non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
5. Provide documentation for each device upon request from the Engineer, with the following information at a minimum:
    a. BACnet Device; MAC address, name, type and instance number
    b. BACnet Objects; name, type and instance number

I. Fault-Tolerance: Select components to operate over a wide range of supply voltage and frequency, with static, transient and short-circuit protection on all inputs and outputs. Protect communication lines against incorrect wiring, static transients and induced magnetic interference. Provide AC coupled devices for connection to communication network to limit device time-outs.

2.03 GRAPHICAL USER INTERFACE SOFTWARE (GUI)

A. Modify the existing graphical user interface to include the full work scope of this project. All new systems shall navigate similar to the existing. All new graphics shall have a similar appearance and operability as the existing. Refer to Part 3.0 for additional requirements.

2.04 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Microsoft Edge, Apple Safari, Google Chrome, or Mozilla Firefox. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:

1. User log-in identification and password shall be required. If an unauthorized user attempts access, a black web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
    a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
        1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
        2) Holidays shall be set using a graphical calendar, without requiring any keyboard entry from the operator.
    b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
    c. View logs and charts.
    d. View and acknowledge alarms.
    e. Setup and execute SQL queries on log and archive information.
7. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired line.

2.05 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.06 OBJECT LIBRARIES

A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D. All control objects shall conform to the control objects specified in the BACnet specification.

E. The library shall include applications or objects for the following functions, at a minimum:

1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on/off events.
2. Calendar Object. The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals

4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start /stop time object properties based on the previous day's performance.
6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.
1. Analog Input Object -Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
2. Analog Output Object -Minimum requirement is to comply with the BACnet standard for data sharing.
3. Binary Input Object -Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
4. Binary Output Object -Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
5. PID Control Loop Object -Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
6. Comparison Object -Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
7. Math Object -Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.

8. Custom Programming Objects -Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC- like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
9. Interlock Object -Provide an interlock object that provides a means of coordination of objects within apiece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
10. Temperature Override Object -Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
11. Composite Object -Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:
1. For BACnet devices, provide the following objects at a minimum:
a. BACnet AI.
b. BACnet AO
c. BACnet BI
d. BACnet BO
e. BACnet Device
2. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

2.07 MATERIALS AND EQUIPMENT

A. General Description: Furnish direct digital electronic control products in sizes and capacities indicated, including valves, dampers, thermostats, clocks, sensors, controllers, and other components required for complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide direct digital electronic control systems with the following functional and construction features, as indicated.

B. Control Valves: Provide factory-fabricated electronic control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system. Except as otherwise indicated, provide valves which mate and match material of connecting piping. Equip control valves with control valve motors, and with proper shutoff ratings for each individual application.
1. Water Service Valves: Globe screwed, equal percentage characteristics with rangeability of 50 to 1, and maximum full flow pressure drop of 5 psig. Motorized ball valves will be acceptable. Motorized butterfly valves will not be acceptable.
2. Single-Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.

3. Double-Seated Valves: Balanced plug-type, with cage type trim providing seating and guiding surfaces for plugs on "top and bottom" guided plugs.
4. Valve Trim and Stems: Polished stainless steel.
5. Packing: ½"-3/4" double O-ring; 1" and above spring-loaded Teflon, self-adjusting.
6. Terminal Unit Control Valves: Provide control valves for control of terminal units including, but not necessarily limited to, convectors, finned tube radiation, and HW coils that are of integral motor type. Provide modulating type valves, electrically actuated by line voltage of 24 Volt.

C. Dampers: Provide automatic control dampers as indicated, with damper frames not less than formed 13-ga. galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16-ga. galvanized steel, with maximum blade width of 8". Equip dampers with motors, with proper rating for each application.
1. Secure blades to 1/2" diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristic, plus size schedule for controlled dampers.
2. Operating Temperature Range: From -20 to 200oF.
3. For standard applications other than outside air dampers, provide parallel blade design (as selected by manufacturer's sizing techniques) with optional closed-cell neoprene edging.
4. Outside air dampers shall be parallel blade design (as selected by manufacturer's sizing techniques) with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm/sq. ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50 inch-pounds.

D. Electric Actuators: Size each motor to operate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. Provide multiple operators to match torque requirements. Control valves and actuators shall be provided to fail to the position indicated in Part 3.0 of this specification section.
1. Electronic actuators shall be direct coupled with a manual override feature and spring return.
2. The actuator shall be direct-coupled over the damper shaft, enabling it to mount directly to the damper assembly without the need for connecting linkage. The fastening clamp assembly shall be a toothed “V” bolt design with associated toothed cradle, creating a “cold-weld” attachment to the damper shaft for maximum strength and eliminating slippage. Spring return actuators shall have a “V” clamp assembly of sufficient size to be directed to a damper jackshaft up to 1.05 inches in diameter when the damper is constructed in this manner. Single bolt or setscrew type fasteners are not acceptable.
3. The actuator shall have an electronic overload or digital rotation sensing circuitry to prevent damage to the actuator through the entire rotation of the actuator. Mechanical end switches or magnetic clutches used to deactivate the actuator at the end of rotation are not acceptable.
4. For power-failure and/or safety applications, and internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable. All spring return actuators shall be capable of both clockwise and counter-clockwise spring return operation by simply changing the actuator mounting orientation. Spring-return actuators shall deliver full torque capacity ratings of the actuator when operating in the fail-safe mode.
5. Proportional (modulating) actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA control operating range. Actuators utilizing Pulse Width Modulating or Tri-State control signals and providing full proportional control of the damper shall also be acceptable. All modulating actuators shall provide 2 to 10 VDC position feedback signal.
6. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC power or more than 8 watts for DC applications. Actuators operating on 120 VAC shall not require more than 10 VA. Actuators operating on 230 VAC shall not require more than 11 VA.
7. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque capacity shall have an external, manual crank for this purpose.
8. All modulating actuators shall have an external, built-in switch to allow the reversing of the direction of rotation.

9. All actuators shall be provided with a conduit fitting and pre-terminated three-foot (minimum) cable, with wires color and/or number coded. Where installation does not require conduit, external terminal strips may be used. At no time shall it be necessary to open the actuator housing to make electrical connections, change direction of rotation, provide damper position indication or manual overrides.
10. All actuators shall be listed under UL Standard 873 and CSA Class 4813-02 certified as required to meet recognized industry standards and local safety and electrical codes.
11. Actuators shall be designed to deliver a minimum of 60,000 full stroke cycles at the actuators rated torque. Actuators shall have a full manufacturers warranty of 2 years from the time of installation.

E. Central Heat Pump By-Pass Valves Special Requirements: By-pass valves installed in variable flow central heat pump systems shall conform to the following additional special requirements. Special requirements apply to all by-pass valves in both the hot water and chilled water systems.
1. Actuators shall be fast acting with a stroke time through the full range of less than 60 seconds.
2. Valves shall be ball or globe for more linear control. Butterfly valves are not acceptable.
3. By-pass valves shall be sized for water flow equal to 1.5 x's the flow of a single heat pump module.
4. Provide direct control of system by-pass valves with corresponding differential pressure transmitter to improve response time. Monitor each valve position through the BAS.

F. Remote-Bulb Thermostats: Provide remote-bulb thermostats of on/off or modulating type, as required by sequence of operation. Provide liquid-filled units designed to compensate for changes in ambient temperature at instrument case. Provide capillary and bulb of copper unless otherwise indicated. Equip bulbs in water lines with separate wells of same material as bulb. Support bulbs installed in air ducts securely, to prevent damage and noise from vibrations. Provide averaging bulbs where shown or specified in operational sequence, consisting of copper tubing not less than 8'-0" in length with either single or multiple-unit elements. Extend tubing to cover full width of duct or unit, and support adequately.
1. Provide scale settings and differential settings where applicable, which are clearly visible and adjustable from front of instrument.
2. Equip on-off remote-bulb thermostats with precision snap switches, and with electrical ratings as required by application.
3. Provide modulating remote-bulb thermostats of potentiometer type constructed so that complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

G. Low-Temperature Protection Thermostats: Provide low-temperature protection thermostats of manual-reset type, with sensing elements 8'-0" or 20'-0" in length. Provide thermostat designed to operate in response to coldest 1'-0" length of sensing element, regardless of temperature at other parts of element. Support element properly to cover entire cross sectional area at duct. Provide separate thermostats for each 25 sq. ft. of coil face area or fraction thereof.

H. Electronic Temperature Sensors: Provide electronic temperature sensors of supersensitive resistance type (RTD) or thermister, which are vibration and corrosion-resistant, and of wall mounted, immersion, duct mounting, averaging or bulb type as required for application.

I. Wall Mounted Space Temperature Sensor (Non-Adjustable): Provide electronic temperature sensors of supersensitive resistance type (RTD) or thermister which are vibration and corrosion resistant. The sensing element shall be adhered to a flat stainless steel plate and be vandal resistant.

J. Wall Mounted Space Temperature Sensor (Adjustable): Provide device with electronic display and temperature sensors of supersensitive resistance type (RTD) or thermister which are vibration and corrosion resistant. At minimum, device shall include local user setpoint adjustment capability and a space temperature read-out. Set point adjustment range and display information for reprogrammable devices shall be reviewed and approved by the Owner prior to implementation. Provide a protective guard where indicated in Part 3 and where indicated on the drawings. The protective guard shall be constructed from a clear heavy-duty polycarbonate material, with holes to freely circulate air for proper sensor operation, access for making setpoint adjustments, a wall mounting plate, and mounting hardware.

K. Insulation for wall mounted space temperature sensors: Closed-cell type with a flame-spread index of 25 or less and a smoke-developed index of 50 or less when tested in accordance with ASTM E84.

L. Pressure Transducers and Transmitters: Provide electronic pressure transmitters of variable capacitance type with stainless steel diaphragm and sensor body, vibration and corrosion-resistant, and weather-resistant for outdoor installations. Suitable for measurement of static or differential pressure with conversion to proportional electrical output.

M. Current Sensors: Provide analog type current sensors to provide actual current draw for each motor. The high/low alarm limits, setpoint, etc. shall be user defined and adjustable.

N. Humidity Sensors: Sensors shall have an accuracy of ± 5% over a range of 20% to 95% RH.

O. Water Flow Switches: Provide water flow switches of stainless steel or bronze paddle types. Provide pressure-flow switches of bellows actuated mercury type or snap-acting type, with appropriate scale range and differential adjustment for service indicated.

P. System Accuracy:
   1. The system shall maintain an end-to-end accuracy for one year from sensor to diagnostic display the following applications.
      a. Space temperature in range of 50-85°F: within plus or minus 0.5°F.
      b. Duct temperature in range of 40-140°F: within plus or minus 0.5°F.
      c. Outside air (OA) temperature in range of minus 40-130°F: within plus or minus 1.0°F.
      d. Water temperature in range of 30-100°F: plus or minus 0.5°F; in range of 100-300°F: within plus or minus 1.0°F.
      e. Pressure: Within plus or minus 2.0 percent of range.

Q. Environmental Conditions: Furnish equipment designed to operate under ambient environmental conditions of 35-120°F dry bulb and 10 to 95 percent relative humidity. Furnish sensors and control elements designed to operate under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

R. Power Line Surge Protection: Protect equipment power supplies from power line surges.

S. Grounding Protection: Protect equipment from any ground fault by providing special grounding as required to prevent equipment failure under any kind of ground fault.

T. Control Relays: Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting Form C contracts, enclosed in dustproof enclosure. Relays shall have a minimum life span rating of 100,000 electrical cycles and 10,000,000 mechanical cycles. Relays shall be equipped with coil transient suppression devices. Provide control relays for all 120/1-volt motors not provided with a motor starter with auxiliary contacts.

U. Control Panels: Provide control panels with suitable brackets for wall or floor mounting, for each supply fan and miscellaneous control systems. Locate panel adjacent to systems served.
   1. Provide steel cabinets as required to contain temperature controllers, relays, switches, and similar devices, except limit controllers and other devices excluded in sequence of operations. Fabricate panels of 14-ga. furniture-quality steel, or 6063-T5 extruded aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color. Provide UL-listed cabinets for use with line voltage devices.
   2. Panel Mounted Equipment: Include temperature controllers, relays and automatic switches, except exclude low-temperature protection thermostats and other devices excluded in sequence of operation. Fasten devices with adjustments accessible through front of panels.
   3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper "minimum-off" positioning switches, "manual-automatic" switches, and dial thermometers.

V. Fault-Tolerance: Select components to operate over a wide range of supply voltage and frequency, with static, transient and short-circuit protection on all inputs and outputs. Protect communication lines against incorrect wiring, static transients and induced magnetic interference. Provide AC coupled devices for connection to communication network to limit time-outs.

W. Carbon Dioxide Sensor: Infrared sensors capable of measuring CO2 over a range of 0-2000 ppm. Sensor accuracy shall be ±75 ppm, and repeatability shall be ±20 ppm, over an operating temperature range of 0°C to 50°C. Provide with 0-10VAC or 4-20mA analog output for connection to the Building Automation System. Provide with Duct inlet and outlet ports, filter tubing, and hardware. Provide with LCD display option.

X. Electric Meters:
1. Manufacturer: Dent Instruments PowerScout HD or approved equal.
2. Description: UL listed multi-circuit meter to provide real time power monitoring for voltage, current, power, energy, and other critical electrical parameters on any combination of single and/or 3-phase systems. The Dent PowerScout product line includes meters with capacities for up to 16 3-phase circuits or 48 single-phase circuits.
3. Circuit Capacity: Refer to the electrical drawings for system configuration and quantity of metered locations. Meters shall be provided with sufficient input capacity as required for the system configuration. Multiple meters may be required to meet input capacity requirements or because of disparate metered locations within the building. It is the intent to aggregate information for the following systems categories.
   a. Total Electri c Energy
   b. HVAC Systems
   c. Interior Lighting
   d. Exterior Lighting
   e. Receptacles
4. Enclosure: UL 94-VO fire rated plastic enclosure.
5. Display: LCD real time-display of meter configuration information and metered data.
6. Power Back-up: Capacitor backed real-time clock to ensure an accurate time stamp on all recorded data records for up to one week. A battery back-up is prohibited.
7. Communication: BACnet and Modbus. BACnet interface shall be integrated into the BAS systems through an ethernet connection.

Y. Energy Meters:
1. Manufacturer: Onicon System-10 or approved equal
2. Description: UL listed thermal energy metering system based on signal inputs for flow and temperature. Provide flow meter and temperature sensors in compliance with this specification section.
3. Display: White, backlit, 16-character, 8-line numeric LCD display. Shall display at a minimum the following:
   a. Total energy
   b. Total flow
   c. Energy rate
   d. Supply temperature
   e. Return temperature
   f. Alarm status
4. Performance: Computing nonlinearly within 0.05%.
5. Enclosure: NEMA 4 for indoor protection against dust and hose directed water.
6. Input power: 24 or 120/1 volt input power.
7. Memory: Non-volatile EEPROM memory to retain all programming parameters and totalized values in the event of a power loss.
8. Communication: BACnet and Modbus. BACnet interface shall be integrated into the BAS system through an ethernet connection.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF BUILDING AUTOMATION SYSTEMS

A. Install Building Automation Systems as indicated, in accordance with system manufacturer's written instructions, and with recognized industry practices, to ensure that energy management and control equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices. Mount controllers at convenient locations and heights.

B. Coordinate with other electrical work, including power distribution and equipment, as necessary to interface installation of energy management and control equipment work with other work.

C. Control Wiring: The term "control wiring" is defined to include providing BAS manufacturer-approved wiring, conduit and miscellaneous materials as required for mounting and connecting control devices. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. Provide plenum rated multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly. Control wiring shall be plenum rated. Tees or wye taps in the communication network are not permitted.

D. Number-code and color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system. Label ends of all conductors in control cabinets with 3M tape indicating control device.

E. Install electrical terminations in UL approved, vented panel enclosures. Locate panels in spaces designated for use as electrical or mechanical equipment rooms. Panels shall be located to provide adequate access and clearance for servicing.

F. All control transformers shall be located in mechanical rooms, janitor closets, or electrical rooms exposed to view. All transformers shall be clearly labeled with the systems it serves.

G. Installation Requirements for Wall Mounted Temperature Sensors: Temperature sensors shown on the drawings are approximate locations and indicate associated equipment for bidding purposes. Coordinate the exact locations with other trades to include electrical or technology components, casework, marker boards, or other building elements and notify the engineer of any conflicts prior to rough-in such that adjustments can be made at no additional cost to the Owner.
   1. Mounting heights (as measured to center line of J-box):
      a. Non-Adjustable: 5'-0" AFF
      b. Adjustable: 3'-10" AFF
   2. Pre-installation conference: Shall be held prior to commencement of field installation and shall be coordinated by the BAS contractor and include the engineer and Owner’s representative. The agenda shall include at a minimum the following:
      a. Review product samples and typical locations.
      b. Sensor features to include field adjustments and custom program features.
      c. Typical mounting heights and locations.
      d. Coordination issues with the work of other trades.
   3. Additional requirements:
      a. Seal all holes in the junction box such that air within the wall cavity cannot flow into the junction box.
      b. Provide insulation in the junction box behind the space temperature sensor. Insulation for sensors mounted at interior walls shall be 1/4-inch thick minimum. Insulation for sensors mounted at exterior walls shall be 1-1/2-inches thick minimum.
      c. Provide protective guards for wall mounted adjustable space temperature sensors that are exposed in gyms and similar spaces at risk of vandalism.
      d. Label each temperature sensor with the equipment tag number of the equipment it serves.

H. Installation Requirements for Control Valves: Controls valves will be installed by another DIV 23 section. Coordinate delivery of controls valves to accommodate the construction schedule.
   1. Pre-installation conference: Shall be held prior to commencement of field installation and shall be coordinated by the BAS contractor and include the piping contractor, commissioning agent, engineer, and Owner's representative. The agenda for the meeting shall include at a minimum the following:
      a. Review of submittals and control valve orientation.
      b. Review of control valve and equipment type.
      c. Sequence of construction, responsibilities and schedule for subsequent operations.
      d. Wiring and testing of installed control valve.
      e. System start-up procedure, including flushing of hydronic system.

I. Reset Limit Controls: Install manual-reset limit controls to be independent of power controllers.

J. Unit-Mounted Equipment: Where control devices are indicated to be unit-mounted, ship relays, switches, etc. to unit manufacturer for mounting and wiring at factory.

K. Grounding: Provide tight equipment grounding connections, sufficiently tight to assure permanent and effective ground, for Building Automation Systems as indicated.

L. Network Area Controllers and Network Switches shall be installed within IT rooms. Refer to Electrical drawings for IT room locations. Coordinate with the Owner's technologies group if equipment will be rack-mounted and required network connection location.

M. All system settings shall conform to the Owner's protocol, including the following. Coordinate with the Owner's IT group and verify settings prior to starting field work.
   1. Owner's IP addresses
   2. Local UDP
   3. Ethernet network
   4. PTP net
   5. Instance range
   6. Display range

3.03 CONTROL VALVE FAIL POSITION

A. Control valves and actuators shall be provided and configured to the fail position indicated on the following chart.

	Pneumatic Actuators		**Electric Actuators**	
Actuator Application	**System Shutdown**	**Loss of Air**	**System Shutdown**	**Loss of Electricity**
Dampers				
Outdoor Air	Closes	Closes	Closes	Closes
Relief Air	Closes	Closes	Closes	Closes
Return Air	Opens	Opens	Opens	Opens (1)
VAV Boxes	Stays Same	Opens	Stays Same	Stays Same
Heat Recovery Wheel Face	Stays Same	Open	Stays Same	Open
Heat Recovery Wheel By-pass	Stays Same	Close	Stays Same	Close
Valves				
AHU Chilled Water	Closes	Opens	Closes	Stays Same
AHU Hot Water	See Sequence	Opens	See Sequence	Stays Same
Terminal reheat	Closes	Opens	Closes	Stays Same
Hydronic system by-pass valve	Opens	Opens	Opens	Opens
Other hot water	Closes	Opens	Closes	Stays Same
Pre-heat in OA below 35 Deg F	See Sequence	Opens	See Sequence	Opens
Pre-heat in OA above 35 Deg F	See Sequence	Opens	See Sequence	Opens

1. Notes:
   a. Return air dampers need no springs if the associated fan is delayed upon start-up to allow the RA damper to properly position to assure that the fan does not start with both the RA and OA dampers closed.

3.04 EXISTING BUILDING SYSTEM WORK SCOPE

A. All existing control system components that are not incorporated into the finished system shall be removed. The extent of demolition shall include but not be limited to the following; pneumatic tubing and pneumatic system components, control wiring, conduit and raceway systems, control cabinets, 120/1 volt power wiring, controllers, sensing devices, and actuators. System components that have been abandoned in previous projects shall be included in the demolition scope. Field verify the extent of demolition required.

B. Protect all system wiring and control components in areas of the building that are renovated. Field verify conditions prior to work starting. Coordinate protection requirements with other trades.

C. Special Pneumatic System Requirements: In renovated areas of the building where it is the intent that pneumatic systems will remain, cap all branch tubing at the nearest pneumatic main. If system leaks persist, as measured by the air compressor cycling, then new pneumatic main air shall be routed to each existing system.

3.05 PROJECT SCHEDULING

A. Provide a detailed critical path schedule within 14 days of the Owner's acceptance of the General Contractor's or Construction Manager's master schedule. The critical path schedule shall incorporate the project phasing plans, and identify all equipment start-up dates. The equipment start-up dates shall be planned such that there is an adequate period of time to complete the quality control requirements and associate self-performed functional performance testing. Coordinate any specific requirements of other trades, such as power wiring, with the General Contractor or construction manager such that the master schedule incorporates these requirements of other subcontractors. The schedule shall prove a methodology to complete all work prior to Substantial Completion.

B. The critical path schedule shall include at a minimum the following elements.
   1. Start and end dates for work in each phase established on the master schedule.
   2. Delivery of submittal documents.
   3. Delivery of control components to other trades such as valves and dampers.
   4. On-site installation of control wiring, controllers, and other control components.
   5. Start-up dates for each piece of equipment.
   6. Functional performance tests for each phase of construction and each piece of equipment.
   7. Delivery of all Quality Control documents.
   8. Start date for Owner's testing agent for each phase and each piece of equipment.
   9. Substantial Completion date.

3.06 FIELD QUALITY CONTROL

A. Upon completion of installation of system hardware and software and after circuitry has been energized, demonstrate capability and compliance of system with requirements. All testing work shall be self performed and completed by the installer and appropriate subcontractors. Where possible, correct malfunctioning units at site, then re-test to demonstrate compliance; otherwise remove and replace with new units, and proceed with re-testing.
   1. Functional Performance Tests: Completion and documentation of all functional performance tests are required as a condition of substantial completion. Provide written notification to the Owner and Engineer including a copy of all testing documents that the systems are ready for the Owner's independent testing agent to begin testing. The functional performance tests shall be in checklist form and include the initials of the assigned tester and the pass date of each item to be tested. The checklists shall include but not be limited to the following:
      a. Visual inspection verifying the installation of all control components and wiring is complete.
      b. Calibration of all analog sensing devices.
      c. Conductance tests of all communication and network wiring.
      d. Visual crosscheck of each control point by making a comparison between the command and field-controlled device.
      e. Verification of loss of power and control failure modes for each control device.
      f. Verification of alarm notifications on the system front end as required in the control sequences.
      g. A checklist of deficiencies that require corrective work by other trades and an anticipated date for completion.
   2. Owner's Testing: Once the functional performance test is submitted, the Owner's functional performance testing/commissioning agent will re-verify performance of the system meeting the requirements of the State Energy Code. For tests that fail, the controls contractor will be responsible to reimburse the Owner for the costs of the failed tests, or for any delays the tester endures due to the work being incomplete. The costs for re-testing will be paid for by the Contractor through deduct charge. Provide assistance and technical support as required to the Owner testing agent to accomplish all functional performance testing and system validation testing.

3. Trend Data: Upon initial start-up of each system, provide trend data for all control and monitoring points. Coordinate with the Owner's Test Agent to transmit all requested data necessary to troubleshoot system. Upon completion of the project, coordinate with the Owner to remove any unnecessary point trends.

3.07 GRAPHICAL USER INTERFACE

A. Provide a sample of each graphic intended for the front end user interface for review and approval by the Engineer and Owner's representative prior to final installation. The graphic must illustrate the following for review.
   1. Intended procedure for navigating between graphics.
   2. Sensor and control signal information available.
   3. Mode of operation status, and safety information available.
   4. Operator override procedures.
   5. Room number and equipment designations.

B. Update final graphics with Owner requested revisions to room name and number identification and equipment identifications. Allocate time for technicians to update graphics and associated engineering drawing and as-built submittals after final installation of system software. The work shall be scheduled to occur prior to substantial completion.

3.08 DEMONSTRATION AND TRAINING

A. Provide demonstration and training for Owner's representative in accordance with Division 1 specification section 01 79 00.

B. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating Building Automation System equipment. In addition, train building personnel to maintain software, that they are capable of initiating changes to computer programs including addition and deletion of points.

C. Provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays as follows:
   1. Provide 16 hours of off-site training for owner's operating personnel. Training shall include:
      a. Explanation of drawings, operations and maintenance manuals.
      b. Walk-thru of the job to locate control components.
      c. Operator workstation and peripherals and operation/functions.
      d. Operator control functions, including graphic generation and field panel programming
      e. Operation of portable operator's terminal.
      f. Explanation of adjustment, calibration and replacement procedures.
   2. Provide additional 4 hours of training to be executed each quarter for a period of one year from final completion of the project, for a total of 16 additional hours for the year.
   3. Technical support staff must be made available to discuss problems as they arise, at no additional cost to the Owner.
   4. If additional such training is required by the Owner, it will be contracted at a later date. Provide description of available local and factory customer training.

3.09 ADJUSTING AND CLEANING

A. Start-Up: Start-up, test, and adjust direct digital electronic control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Final Adjustment: After completion of installation, adjust controllers, sensors and similar equipment provided as work of this section.
   1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

3.10 SIGNAGE

A. Provide an engraved plastic laminate sign at all push buttons in occupied spaces to identify the function of the button. Coordinate exact language of each sign with the Owner's representative. Refer to specification section 23 05 53 for sign requirements.

B. At each room temperature sensor, provide a sticker label that identifies the equipment controlled. Font shall be Avalon, ¼" height, and black in color on a transparent background.

3.11 CONTROL SEQUENCES AND POINTS SCHEDULES

A. Every connected analog output (AO), analog input (AI), digital output (DO), and digital input (DI) represents a "point" where referred to in this specification. Refer to Specification Section 23 09 93 for specific control sequences and for complete listing of these points. Each analog output shall have its own distinct control loop. All analog points shall be adjustable through the BAS

B. Each air handling unit, exhaust fan, unit heater, or other equipment indicated to be controlled by a time clock schedule through the BAS shall be capable of being individually programmed for its own schedule of operation. Review time of day scheduling for equipment with the Owner's representative. Modify the equipment schedules as necessary to group equipment together on a single schedule as desired to more easily facilitate changing schedules in the building. Provide a single global holiday schedule for all equipment within the building.

END OF SECTION 23 09 00

SECTION 23 09 50
VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes variable frequency moto controllers for low-voltage (600 V and less) AC motors applications.

1.02 DEFINITIONS

A. BMS: Building management system.
B. IGBT: Integrated gate bipolar transistor.
C. LAN: Local area network.
D. PID: Control action, proportional plus integral plus derivative.
E. PWM: Pulse-width modulated.
F. VFC: Variable frequency controller.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include each installed unit's type and details; namplate legends; short-circuit current rating of integrated unit; Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction; and features, characteristics, ratings, and factory settings of each motor-control center unit. Include power, signal, and control wiring diagram.

1.04 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
B. Submit field quality control reports.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
    1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
E. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: 0 to 40 deg C.
   2. Humidity: Less than 90 percent (noncondensing).
   3. Altitude: Not exceeding 3300 feet.

1.08 COORDINATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
   2. Danfoss Inc.; Danfoss Electronic Drives Div.

2.02 VARIABLE FREQUENCY CONTROLLERS

A. General: Provide variable frequency controllers as indicated on the drawings and as required to accomplish the control intent as described in Division 23 Section 23 09 93 "BAS Sequence of Operations."

B. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
   1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

C. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

E. Unit Operating Requirements:
   1. Input ac voltage tolerance of 208 V, plus or minus 5 or 380 to 500 V, plus or minus 10 percent as required to match motor horsepower.
   2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
   3. Minimum Efficiency: 96 percent at 60 Hz, full load.
   4. Minimum Displacement Primary-Side Power Factor: 96 percent.
   5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   6. Starting Torque: 100 percent of rated torque or as indicated.
   7. Speed Regulation: Plus or minus 1 percent.

F. Harmonic Voltage Distortion:
   1. The inverter output waveform shall be an RMS value, including voltage harmonics, not exceeding 1.05 fundamental at all normal operating speeds. Limit contribution of variable speed control 5th, 7th or 9th harmonic voltage to the electrical distribution system not beyond these limits.

G. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
   1. Electrical Signal: 4 to 20 mA at 24 V.

H. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 2 to a minimum of 22 seconds.
   4. Deceleration: 2 to a minimum of 22 seconds.
   5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

I. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors.
   2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
   3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 30 performance.
   4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
   5. Instantaneous line-to-line and line-to-ground overcurrent trips.
   6. Loss-of-phase protection.
   7. Reverse-phase protection.
   8. Short-circuit protection.
   9. Motor overtemperature fault.

J. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

N. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.

O. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

P. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).

6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

Q. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
a. 0 to 10-V dc.
b. 0-20 or 4-20 mA.
c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.
e. RS485.
f. Keypad display for local hand operation.
3. Output Signal Interface:
a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
1) Output frequency (Hz).
2) Output current (load).
3) DC-link voltage (VDC).
4) Motor torque (percent).
5) Motor speed (rpm).
6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
a. Motor running.
b. Set-point speed reached.
c. Fault and warning indication (over temperature or over current).
d. PID high- or low-speed limits reached.

R. Communications: Provide an ANSI/ASHRAE standard 135-2001 BACnet protocol interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

S. Integral Input Disconnecting Means: NEMA KS 1, nonfusible switch, with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.

T. DVDT Filter: Provide a DVDT Filter on the VFC when the drive is located more than fifty feet from the motor. Refer to Drawings for exact locations.

2.03 ENCLOSURES

A. NEMA 250, Type 1.

2.04 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
   3. Motor current (amperes).
   4. DC-link voltage (VDC).
   5. Motor torque (percent).
   6. Motor speed (rpm).
   7. Motor output voltage (V).

F. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

2.05 FACTORY FINISHES

A. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested VFCs before shipping.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.

3.02 APPLICATIONS

A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.03 INSTALLATION

A. Variable frequency motor controllers will be installed by the Electrical Contractor. Coordinate equipment delivery schedule and equipment installation requirements with the Electrical Contractor.

3.04 IDENTIFICATION

A. Identify VFCs, components, and control wiring according to Division 23 Section "Identification for HVAC Piping and Equipment."

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.05 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.06 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
   3. Report results in writing.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection. Certify compliance with test parameters.
   2. Perform shaft arc testing.
   3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.07 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.08 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate and maintain VFDs. Refer to Division 01 Section “Demonstration and Training.”
   1. Required Time: 1 hour.

END OF SECTION 23 09 50

SECTION 23 09 93
BAS SEQUENCE OF OPERATIONS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. The Section includes Control Sequences and Points Schedule For:

1. Dedicated Outside Air Systems
2. Exhaust Fans – Scheduled On/Off
3. Cabinet Unit Heaters
4. Horizontal Unit Heaters
5. Finned Tube Radiation
6. Duct Coils
7. Fan Coil Units
8. Ceiling-Mounted or Wall-Mounted Computer Room Air Conditioning Units
9. Humidifier HU-#
10. Miscellaneous

1.02 DEFINITIONS

A. DDC: Direct digital control.

B. VAV: Variable air volume.

1.03 CONTROL SEQUENCES

A. Refer to the attached control sequences and points schedule for required Building Automation Systems work.

PART 2 PRODUCTS - NOT APPLICABLE

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. System Programming: Provide the most current version of the system software that is available prior to the date of substantial completion.

1. It is the intent that the system be as easy as possible for the building operator to navigate. Modify the system programming and graphics as to include descriptors of the actual equipment names in addition to point mapping acronyms. In addition provide the following front-end graphic interface features:
   a. Graphic representation of each piece of equipment.
   b. Configuration of major systems including but not limited to central plants.
   c. Control points displayed on each page. Coordinate with the Owner's representative as to level of detail to include on each page.
   d. Major equipment including air handling equipment graphics shall include a secondary text page with detailed system points and parameters. Coordinate with the Owner's representative as to level of detail to include on each page.
   e. Navigation tools and page links. Provide additional navigation features at the request of the Owner.
   f. Building floor plan graphics showing air handling unit zone boundaries.
   g. Building floor plan graphics showing each temperature control zone with space temperatures represented.
   h. Building floor plan graphics with lighting control zones.
   i. Building floor plan graphics to show exhaust fan locations.
   j. A graphic page to show utility use summary information.
   k. Graphic page to show a summary of equipment time of day schedules.
   l. Graphic page to show a summary of dirty filter alarms.
2. For all existing equipment, compare the currently installed control program to the control sequences published here in and submit a report to the engineer of discrepancies in the control intent. At the direction of the engineer, modify the existing control sequences as required.

3. Complete the time of day program scheduling for all equipment at the direction of the Owner's representative. Modify the equipment schedules as necessary to associate equipment in control groups to minimize the number of schedules in the system. Provide a global holiday schedule for all equipment in the building.
4. Coordinate with the Owner's representative for the initial temperature setpoints for each space.

B. Building Automation System Alarms: Alarms generated by the building systems shall be categorized as either critical or non-critical and be handled with the attributes as listed in items 1 and 2 below. Any alarms identified in specific control sequences that are in addition to those listed below shall be handled as non-critical alarms.
1. Critical Alarms:
   a. Only generated when the alarmed system is enabled.
   b. Send an email notification to the Owner's personnel as designated 24 hours a day, 7 days a week.
   c. Log all critical alarms to server log.
   d. Generate pop up alarm box at the local display for building personnel as defined by user log-in.
2. Non-Critical Alarms:
   a. Only generated when the alarmed system is enabled.
   b. Log all non-critical alarms on server log.
   c. Generate pop-up alarm box at the local display for building personnel as defined by user log-in.
3. All Space Temperature Sensors:
   a. Critical:
      1) Space temperature less than 45 degrees Fahrenheit (7.22 degrees Celsius). for a time period greater than 15 minutes.
4. AHU/RTU – Constant Volume: Space temperature variation setpoint color-coded on floor plan graphic. All space temperatures are critical alarmed if less than 45 degrees Fahrenheit (7.22 degrees Celsius). for a time period greater than 15 minutes.
   a. Non-Critical:
      1) Freeze-stat
      2) Duct smoke detector
      3) Static safety switches
      4) Filter differential pressure
      5) High discharge air temperature exceeds 110 degrees Fahrenheit (43.33 degrees Celsius). for a time period greater than 15 minutes
      6) Low discharge air temperature less than 38 degrees Fahrenheit (3.33 degrees Celsius). for a time period greater than 15 minutes
      7) Supply fan status
5. Data room – space temperature greater than 78 degrees Fahrenheit (25.56 degrees Celsius) for a time period greater than 15 minutes.
6. Unit Heaters and Cabinet Unit Heaters:
   a. Critical:
      1) Space temperature is less than 45 degrees Fahrenheit (7.22 degrees Celsius) for a time period greater than 15 minutes
   b. Non-Critical:
      1) Fan status
7. Miscellaneous:
   a. Critical:
      1) Generator alarm

3.02 CONTROL SEQUENCE AND POINTS SCHEDULE
FOR: DEDICATED OUTSIDE AIR SYSTEMS WITH HEAT RECOVERY

A. General:
1. Air Handling Systems: All equipment indicated shall be controlled by the same software defined occupied/unoccupied schedule through the Building Automation System. The operator shall have the option of scheduling each induction displacement unit and chilled beam zone separately.
   a. **AREA SERVED: A, B, & C**
      Dedicated Outside Air Unit AHU-1
      Dedicated Outside Air Unit AHU-2
      Dedicated Outside Air Unit AHU-3
      Energy Recovery Ventilator ERV-1
      Energy Recovery Ventilator ERV-2
      Energy Recovery Ventilator ERV-3
2. Provide the supply and exhaust fan variable speed drives. Installation by Div 26 contractor. Refer to schedules for quantities.
3. Provide the outside air and exhaust air electric damper actuators. All dampers are furnished and installed by the DOAS unit manufacturer.
4. Provide the hot water coil valves and electric actuators; refer to equipment schedules for 2 or 3 way valves. Installation specified under another DIV 23 section.
5. Smoke detectors are furnished and installed by the Electrical Contractor. Coordinate requirements.
6. Provide and wire static pressure safety switches.
7. Provide and wire all electrical interlocks to other equipment associated with this system, as indicated or otherwise necessary for proper system operation.
8. Provide and wire a carbon dioxide sensor in the return air stream for monitoring purposes only.

B. Control Sequence:
1. Occupied Mode:
   a. The system shall be capable of being indexed to occupied mode be a timeclock schedule through the EMCS, initial schedule 24/7 (adj).
   b. All fans associated with this system shall run continuously.
   c. The outside air and exhaust air dampers shall open fully.
   d. Fan Capacity Control:
      1) Provide a “soft start” ramp function to bring fans to speed slowly.
      2) Provide a duct static pressure sensor and PID control loop to set the supply fan speed control to maintain the duct static pressure setpoint (software adjustable).
      3) Work with test and balance contractor to set the duct static pressure setpoint.
   e. Building Pressure Control:
      1) The system is designed for 100% outside air with each area served being slightly positive. There is no active building pressurization control.
   f. Discharge Air Temperature Reset:
      1) The discharge air shall be reset between a minimum and maximum temperature operator adjustable setpoint. The maximum temperature shall be initially set for 65.0 degrees. The minimum temperature shall be initially set for 55.0 degrees. Upon initial system start-up, the system shall start at 55.0 degrees for cooling and 60 degrees for heating.
   g. DX Coil Control:
      1) The Condensing unit shall operate on its own controls to maintain the discharge air temperature setpoint.
   h. Hot Water Valve Control:
      1) The system shall be indexed to the heating mode when hot water is available, or the outside air is below 10°F (adj).
      2) The heating coil valve shall modulate to maintain a coil leaving air temperature of 70°F.

2. Safeties:
    a. Smoke - Transmit alarm to EMCS when smoke is detected in duct system.
    b. Static Pressure Switch - Provide a static pressure sensor and safety switch located in the unit outside air and relief air chambers, supply duct, and return duct to shutdown supply fans and return fans, and transmit an alarm to the EMCS, when the static pressure is below the setpoint of the sensor.
    c. High Discharge Air Temperature - De-energize fan and transmit alarm to EMCS when the discharge air temperature exceeds 90.0 degrees.
    d. Low Discharge Air Temperature - De-energize fan and transmit alarm to EMCS when the discharge air temperature drops below 45.0 degrees.

C. Alarms:
1. Generate an alarm when one of the following devices trips:
    a. Duct Smoke Detectors
    b. OA Air Static Safety Switch
    c. Supply Air Static Safety Switch.
    d. Relief Air Static Safety Switch
2. Generate an alarm when the exhaust fan control is on but the status of the exhaust fans is off.
3. Generate an alarm when the supply fan control is on but the status of the supply fan is off.
4. Generate an alarm when the discharge air temperature is 5°F above or below the setpoint for more than a 10-minute duration (all variables operator adjustable).
5. Generate an alarm when the discharge air static pressure is 0.5” wc above or below the setpoint for more than a 5 minute duration (all variables operator adjustable).
6. Generate an alarm when the mixed air temperature is 45°F or below for more than a 5 minute duration (all variables operator adjustable).
7. Generate an alarm if the filter differential pressure is above setpoint (each filter). Display the filter alarms on a global filter summary page for the building.

D. Points Schedule:
1. Provide at a minimum the following control points for each system and as required to accomplish the indicated control sequences.

(DO)	Supply Fan Control (each)	(AI)	Filter Differential Pressure (Each)
(DI)	Supply Fan Status (Current Sensor) (each)	(AO)	OA Damper Modulation
(DO)	Exhaust Fan Control (each)	(AO)	Relief Air Damper Modulation
(DI)	Exhaust Fan Status (Current Sensor) (each)	(AI)	Supply Duct Static Pressure
(AO)	Supply VFD Modulation (each)	(DI)	Smoke Alarm
(AO)	Exhaust VFD Modulation (each)	(AI)	Building Differential Static Pressure
(AI)	Discharge Air Temperature	(AO)	HW Valve Modulation (Each Valve)
(AI)	Outside Air Temperature	(AO)	DX Coil Modulation (Each)
(AI)	Return Air Temperature	(AI)	Outside Air Enthalpy
(AI)	Exhaust Air Temperature	(AI)	Supply Airflow
		(AI)	Exhaust Airflow
		(AI)	Outside Air Airflow
		(DI)	Supply Airflow Status
		(AI)	Return Air Carbon Dioxide Level

3.03 CONTROL SEQUENCE AND POINTS SCHEDULE
FOR: VRF HEAT PUMP SYSTEM CONTROL

A. Gener
1. The VRF System comes with factory packaged controls furnished and installed by another Division 23 contractor. System will have BACnet gateway. Connect to BACnet gateway to receive all points as described here-in. Intent is Owner can monitor and edit inputs (some), but not change factory sequence/s.
2. Provide new floorplan graphics for equipment status and temperature indication in each space. Pull status and temps from VRF BACnet controls.
3. Wire to room occupancy sensors provided by Division 26. Override room temperature setpoint within +/- 5°F range (adjustable for each zone), when room is unoccupied.

B. Control Sequence
1. Occupied Mode
a. The VRF system shall be controlled by a software defined occupied/unoccupied scheduled through the BAS. It is the BAS contractor's responsibility to program all occupied/unoccupied schedules for all VRF fan coils.
b. All space temperature setpoints shall be able to be communicated from the BAS to the VRF system through the BACnet gateway.

C. Points Schedule

Provide at a minimum the following control points for each system and as required to accomplish the control sequences indicated.

(DO)	VRF System Enable/Disable	(DI)	VRF Equipment Status (each component)
(DI)	Space Temperature (each zone)	(DI)	Occupancy Sensor (each)

Provide the following mapped points from the BACnet Gateway from the VRF control system. Inputs shall be editable and most points monitored only. Editable inputs noted below:

On/Off State, Number of On/Off, Cumulative Operation time
All alarms
Room Temp (Editable)
Set Temp (Editable)
Set Temp Heat (Editable)
Set Temp Cool (Editable)
Set Temp Auto (Editable)
Filter Sign
Filter Sign Reset (Editable)
M-NET Communication State
System Forced Off
Air Direction Setup (Editable)
Air Direction State
Set High Limit Setback Temp (Editable)
Set Low Limit Setback Temp (Editable)
Group Apportioned Electric Energy
Interlocked Units Electric Energy
Trend Log Room Temp
Trend Log Room Temp
Trend Log Interlocked Units Electric Energy

3.04 CONTROL SEQUENCE AND POINTS SCHEDULE FOR: EXHAUST FANS – SCHEDULED ON/OFF

A. General
   1. Exhaust fans as indicated on the drawings and unless indicated to be controlled by another method, shall be controlled on/off by a time of day schedule through the BAS system.
   2. Each fan shall be capable of being individually controlled. The final time of day schedules and how systems may be grouped together shall be reviewed and approved by the Owner prior to occupancy.
   3. 480/3 volt exhaust fans are furnished with magnetic contactors or motor starter/switches by Division 26. Division 23 to provide all required control relays for all exhaust fans. Coordinate an accessible relay location for installation by Division 26.
   4. Provide motorized dampers and 2-position electric actuators where noted on the drawings. Coordinate connection requirements to each fan with the fan manufacturer. Provide the damper actuator with a compatible voltage, damper end switch, and control transformer where necessary. Damper installation by another DIV 23 section.
   5. Provide and wire all electrical interlocks to other equipment associated with this system, as indicated or otherwise necessary for proper system operation.

B. Control Sequence
   1. Occupied Control
      a. Enable each exhaust fan to run continuously.
      b. For exhaust fans provided with motorized dampers, the damper shall prove fully open prior to enabling the exhaust fan.
      c. For exhaust fans serving areas where hazardous or fume producing materials are stored (i.e. chemical storage rooms) shall be initially scheduled to run continuously.
   2. Unoccupied Control
      a. Disable each exhaust fan off.
      b. For exhaust fans with motorized dampers, fully close the damper when the fan is disabled.

C. Alarms
   1. Generate an alarm if the fan is enabled and its status is off.

D. Points Schedule
   1. Provide at a minimum the following control points for each system and as required to accomplish the control sequences indicated.
      (DO) Exhaust Fan Control
      (DI) Exhaust Fan Status
      (DO) Motorized Damper Control
      (DI) Motorized Damper End Switch
      (DI) Momentary Push Button

3.05 CONTROL SEQUENCE AND POINTS SCHEDULE FOR: CABINET UNIT HEATERS

A. General
   1. Provide a space temperature sensor and control sequence for each cabinet unit heater.
   2. Provide 2-way modulating heating control valves and actuators. Installation is work of another Division 23 Section.
   3. Provide and wire a surface mounted aquastat. Coordinate installation with the Division 26 contractor.
   4. The unit heaters shall be indexed between its occupied and unoccupied modes by a timeclock schedule through the BAS system.

B. Control Sequence
   1. Occupied Mode
      a. The heating coil valve shall modulate open to maintain a space temperature setpoint initially set for 68.0 Deg F (adjustable).
      b. An aquastat mounted on the return hot water line shall de-energize fan motor when fluid temperature falls below setpoint of aquastat (adjustable). The aquastat and the space temperature call for heat shall be wired in series such that the unit heater fan will run only if there is a call for heat and there is hot water available in the system.
      c. To comply with the Energy Code, the space temperature setpoint for unit heaters serving vestibules shall be set for 60.0 Deg F and the control valve shall be fully closed and the operation locked out when the outside air temperature is greater than 45.0 Deg F.
   2. Unoccupied Mode
      a. The heating coil valve shall modulate open to maintain a unoccupied space temperature setpoint initially set for 50.0 Deg F (adjustable).
      b. The aquastat and the space temperature call for heat shall be wired in series such that the unit heater fan will run only if there is a call for heat and there is hot water available in the system.
      c. To comply with the Energy Code for unit heaters serving vestibules, the control valve shall be fully closed and the operation locked out when the outside air temperature is greater than 45.0 Deg F.

C. Alarms
   1. Generate an alarm when space temperature drops 5°F below setpoint for 5-minute duration in heating mode.

D. Points Schedule
   1. Provide at a minimum the following control points for each system and as required to accomplish the control sequences indicated.
      (AI) Space Temperature
      (AO) Heating Valve Modulation
      (AI) Outside Air Temperature

3.06 CONTROL SEQUENCE AND POINTS SCHEDULE FOR: HORIZONTAL UNIT HEATERS

A. General
   1. Provide a space temperature sensor and control sequence for each horizontal unit heater.
   2. Provide 2-way modulating heating control valves and actuators. Installation is work of another Division 23 Section.
   3. Provide and wire a surface mounted aquastat. Coordinate installation with the Division 26 contractor.
   4. The unit heaters shall be indexed between its occupied and unoccupied modes by a timeclock schedule through the BAS system.

B. Control Sequence
   1. Occupied Mode
      a. On a call for heat from a space temperature sensor, the heating valve shall modulate open, to maintain a temperature setpoint of 70.0 degrees.
      b. An aquastat mounted on the return hot water line shall de-energize fan motor when fluid temperature falls below setpoint of aquastat (adjustable). The aquastat and the space temperature call for heat shall be wired in series such that the unit heater fan will run only if there is a call for heat and there is hot water available in the system.
   2. Unoccupied Mode
      a. On a call for heat from a space temperature sensor, the heating valve shall modulate open to maintain a temperature setpoint of 55.0 degrees.
      b. An aquastat mounted on the return hot water line shall de-energize fan motor when fluid temperature falls below setpoint of aquastat (adjustable). The aquastat and the space temperature call for heat shall be wired in series such that the unit heater fan will run only if there is a call for heat and there is hot water available in the system.

C. Alarms
   1. Generate an alarm when the space temperature drops 5°F below setpoint for a 5-minute duration.

D. Point Schedule
   1. Provide at a minimum the following control points for each system and as required to accomplish the control sequences indicated.
      (AI) Space Temperature
      (AO) Heating Valve Modulation

3.07 CONTROL SEQUENCE AND POINTS SCHEDULE FOR: FINNED TUBE RADIATION

A. General
   1. Provide a space temperature sensor and control sequence for each heating terminal device. Refer to the drawings for system configuration and additional information regarding temperature control zones.
   2. Provide 2-way modulating heating control valves and actuators. Installation is work of another Division 23 section.
   3. The system shall be indexed between their occupied and unoccupied modes by a timeclock schedule through the BAS system.

B. Control Sequence
   1. Occupied Mode
      a. On a call for heating, the radiation valves shall open 25% (operator adjustable) before the heating coil valve associated with the air handling unit heating zone begins to modulate. On a continued call for heat, the reheat valve shall modulate in unison with the radiation valve to maintain a temperature setpoint of 72.0 degrees.
   2. Unoccupied Mode
      a. On a call for heating from the space temperature sensor, the heating valve shall modulate open to maintain a space temperature setpoint of 55.0 degrees.
      b. For areas also served by air handling systems, the finned tube radiation valve shall be fully open prior to the air handling unit heating zone sending a request for heating.

C. Alarms
   1. Generate an alarm when the space temperature drops 5°F below setpoint for a 5-minute duration in the heating mode.

D. Point Schedule
   1. Provide at a minimum the following control points for each system and as required to accomplish the control sequences indicated.
      a. (AI) Space Temperature
      b. (AO) Reheat Valve Modulation
      c. (AO) Radiation Valve Modulation

3.08 CONTROL SEQUENCE AND POINTS SCHEDULE FOR: DUCT COILS

A. General
   1. Provide a space temperature sensor and control sequence for each duct coil. Refer to the drawings for additional information. Duct coils serving multiple rooms may have multiple sensors.
   2. Provide 2-way modulating heating control valves and actuators. Installation is work of another Division 23 section.
   3. The system shall be indexed between their occupied and unoccupied modes by a timeclock schedule through the BAS system.

B. Control Sequence
   1. Occupied Mode
      a. Radiation (if applicable) shall be first stage of heat, prior to modulating the reheat valve open. Refer to radiation control sequence.
      b. On a call for heating from the space temperature sensor, the heating valve shall modulate open to maintain a temperature setpoint of 72.0 degrees. When the heating valve is fully open and space temperature is below setpoint, send a heating request to the air handling system. When the heating valve is fully closed and the space temperature is above setpoint, send a cooling request to the air handling system.
      c. The reheat coil valve shall be modulated to maintain a discharge air temperature between a minimum temperature initially set for 50.0 Deg F (adjustable) and a maximum temperature initially set for 115 Deg F (adjustable).
   2. Unoccupied Mode
      a. Where finned tube radiation is installed, it shall be the first stage of heat. The finned element control valve shall modulate open to maintain an unoccupied temperature setpoint initially set for 55.0 Deg F. Refer to the radiation control sequence.
      b. When the radiation control valve is in the full open position and the space temperature drops below heating setpoint plus a 3 Deg F differential, then a heating request shall be sent to the associated air handling unit.
      c. The coil control valve shall be closed unless the associated air handling system is in operation and a "heating available" signal has been broadcast over the network by the central plant control module. On a call for heating from the space temperature sensor, the heating valve shall modulate open to maintain the unoccupied temperature setpoint.
      d. When the coil control valve is fully open and the space is still below the unoccupied setpoint plus a 3 Deg F differential, then a "heating request" shall be transmitted over the network to the respective air-handling unit. Reset the discharge air temperature as described under the air handling unit sequence.

C. Alarms
   1. Generate an alarm when the space temperature drops 5°F below setpoint for a 5-minute duration in the heating mode.

D. Point Schedule
   1. Provide at a minimum the following control points for each system and as required to accomplish the control sequences indicated.
      (AI) Space Temperature
      (AO) Heating Valve Modulation
      (AI) Discharge Air Temperature

3.09 CONTROL SEQUENCE AND POINTS SCHEDULE FOR: CEILING-MOUNTED OR WALL-MOUNTED COMPUTER ROOM AIR CONDITIONING UNITS

A. General
   1. The computer room cooling units are split direct expansion systems including an evaporator unit installed in the space and a remote condensing unit. Refer to the drawings for additional information as to system quantity and configuration.
   2. All controls are provided with the unit by another Division 23 Section. Refer to other Division 23 sections for additional information. The Building Automation System contractor shall install and wire all controls as required for the complete operation of the unit. Coordinate installation requirements with the unit manufacturer.
   3. Provide space temperature sensor.

B. Control Sequence
   1. All controls provided by another Division 23 section. There is no control sequence associated with this equipment.

C. Alarms
   1. Generate an alarm if the space temperature is greater than 5□F above setpoint for a period greater than 30 minutes.

D. Points Schedule
   1. Provide at a minimum the following control points and as required to accomplish the control sequences indicated.
      (AI) Space Temperature

3.10 CONTROL SEQUENCE AND POINTS SCHEDULE FOR: HUMIDIFIERS HU-1, HU-2, HU-3

A. General
   1. The humidifier is a self-contained electric resistance canister style humidifier.
   2. Install and wire the humidistat and other field installed control components provided with the humidifier. Coordinate connection requirements with the equipment manufacturer. In addition, provide a space humidity sensor for remote monitoring of the space humidity on the automation system front-end.
   3. Display space humidity on the front-end automation system graphics.

B. Control Sequence
   1. The humidifier shall be enabled by the space humidity sensor and operate on its internal controls to maintain the space humidity set point.

C. Alarms
   1. Generate an alarm when the space humidity is less than 30% for a time period greater than 30 minutes.

D. Points Schedule
   1. Provide at a minimum the following control points for each system and as required to accomplish the indicated control sequences.
      (AI) Space Humidity

3.11 CONTROL SEQUENCE AND POINT SCHEDULE FOR: MISCELLANEOUS

A. General

1. Provide run status and fault alarm on each emergency generator and status of each emergency generator transfer switch. Refer to the electrical drawings quantities and locations. Coordinate with the equipment manufacturer and Division 26 contractor for connection requirements. Provide additional equipment and components, as may be necessary to complete the connections.
2. The Temperature Controls Contractor shall request and coordinate, in advance, the work with the electrical power supplier to receive a proper demand pulse/signal (3-wire pulse). Fees or service charges to attain the required signal shall be paid by this contractor. Provide required meters, relays, and related wiring, equipment, and connections for a complete and fully operable system. Modify the home page on the front-end graphics to include an electric use summary including peak demand and daily, weekly, and annual totals.

B. Alarms

1. Generate an alarm when the generator has a fault alarm.

C. Point Schedule

1. Provide at a minimum the following control points for each system and as required to accomplish the control sequences indicated.
   (AI) Electric Demand
   (DI) Generator Status (each)
   (DI) Generator Fault (each)
   (DI) Transfer Switch Status (each)

END OF SECTION 23 09 93

SECTION 23 21 13
HYDRONIC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating system.
   2. Hybrid VRF water system.

1.02 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Hot-Water Heating Steel Piping: 150 psig at 200 deg F.
   2. Hot-Water Heating Copper Piping :150 psig at 200 deg F.
   3. Hybrid VRF Water Copper Piping: 150 psig at 200 deg F.
   4. Makeup-Water Piping: 80 psig at 150 deg F.
   5. Condensate-Drain Piping: 150 deg F.
   6. Blowdown-Drain Piping: 200 deg F.
   7. Air-Vent Piping: 200 deg F.
   8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated.
B. Provide chemical treatment information.
   1. Water quality: Water analysis to determine water quality available at the site.
   2. Treatment plan: Water treatment consultants recommended treatment plan.
   3. Chemical data sheets: Manufacturer’s product information to include material safety data sheets.
   4. Glycol: Product information with water treatment consultant approval.

1.04 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
B. Warranty: Submit special warranty specified in this Section.
C. Submit field quality control reports.

1.05 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Glycol: Provide a minimum quantity of 55 gallons of premixed glycol for each system upon final closeout of the project. Provide 55-gallon barrel for glycol storage

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

E. Copper Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
   a. Viega.
2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.02 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.03 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.04 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
   1. Factory-fabricated union assembly, for 250-psig minimum working pressure at 300 deg F.

D. Dielectric Flanges:
   1. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
   1. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures

F. Dielectric Couplings:
   1. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples:
   1. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.05 VALVES

A. Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Bronze, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong Pumps, Inc.
      b. IMI Hydronic Engineering, Inc.
      c. Gerand Engineering Co.
      d. Griswold Controls.
      e. Taco.
      f. Nibco
      g. Tour & Andersson; available through Victaulic Company of America.
      h. Nexus Valve
      i. HCi, Hydronic Components, Inc.
   2. Body: Bronze, dezincified brass, and/or Ametal ball or plug type with calibrated orifice or venturi.
   3. Ball: Brass or stainless steel.
   4. Plug: Resin.
   5. Seat: PTFE or EPDM.
   6. End Connections: Threaded or socket.
   7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   8. Handle Style: Lever, with memory stop to retain set position.
   9. CWP Rating: Minimum 125 psig.
   10. Maximum Operating Temperature: 250 deg F.

C. Cast-Iron or Steel, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong Pumps, Inc.
      b. IMI Hydronic Engineering, Inc.
      c. Gerand Engineering Co.
      d. Griswold Controls.

e. Taco.
f. Tour & Andersson; available through Victaulic Company of America.
g. Nibco
h. Nexus Valve
i. HCi, Hydronic Components, Inc.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE or EPDM.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F

2.06 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Calefactio.
5. Taco.
6. Thrush Co., Inc.
7. Grundfos
8. Spirotherm

B. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:
1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Diaphragm or Bladder Type Expansion Tanks:
1. Tank: Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm or Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.07 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Cast Iron Strainers:
      a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection with blowdown valve and cap with chain.
      b. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
      c. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
      d. CWP Rating: 125 psig.
   2. Bronze Strainers:
      a. Body: Low lead cast bronze ASTM B 584 with threaded drain connection and blowdown valve with cap and chain.
      b. End connections: Threaded or solder end connections.
      c. Strainer Screen: 20 mesh 304 stainless steel.
      d. Ratings: 400 psi WOG at 210° F. 125 psi WSP at 353° F.

B. Basket Strainers:
   1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.

C. T-Pattern Strainers:
   1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
   2. End Connections: Grooved ends.
   3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
   4. CWP Rating: 750 psig.

D. Stainless-Steel Bellow, Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4-inch misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

E. Spherical, Rubber, Flexible Connectors:
   1. Body: Fiber-reinforced rubber body.
   2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
   3. Performance: Capable of misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

F. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

2.08 COMBINATION STRAINERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bell and Gossett.
   2. HCi, Hydraulic Companies, Inc.
   3. IMI Hydronic Engineering.
   4. Victaulic.

B. Combination shut-off valve, strainer, and union valve with the following features.
   1. Body: Dezincified copper alloy or brass.
   2. Shut-Off Valve: Stainless steel ball and stem with PTFE ball seat.
   3. Stem Seals: EPDM o-rings or viton.
   4. Strainer: 20 mesh stainless steel.

5. Pressure gauge connections: Integral seals for portable differential pressure meter.
6. End connections: Screwed or sweat fittings.
7. Union gasket: EPDM.
8. CWP rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg. F.

2.09 CHEMICAL TREATMENT

A. Provide the services of a water treatment consultant to provide the make-up water analysis, systems testing, and treatment plan required in Part 3.0 of this specification. The treatment consultant shall provide all cleaning agents, corrosion inhibitors, and other chemicals as recommended in the treatment plan.

B. Provide a pre-mixed solution of deionized water and industrial grade glycol for final fill of the system. The glycol shall meet the minimum concentration listed in part 3.0 of this specification and shall include corrosion inhibitors and environmental stabilizer additives. The final fill solution shall be approved by the water treatment consultant and be provided by the mechanical contractor.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

A. Above Ground Hydronic Hot Water Heating System Piping (unless otherwise specified here-in):
   1. Up to 2½": Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Up to 2½": Type L, drawn copper tube with pressure-seal fittings and joints.
   3. 1½" and Larger: Schedule 40 steel pipe with welded joints and fittings.

B. Above Ground Hydronic Hybrid VRF Piping (between branch controller and terminal units):
   1. Up to 2½": Type L, drawn copper tube with pressure-seal fittings and joints.

C. Makeup-water piping:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

F. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.02 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install balancing valves at each branch connection to return main.

C. Install balancing valves in the return pipe of each heating or cooling terminal.

D. Install balancing valve in the by-pass leg of all three way control valves at each heating and cooling coil.

E. Install check valves at each pump discharge and elsewhere as required to control flow direction.

F. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

G. Combination strainers may be installed in lieu of individual piping components as indicated on the drawings for pipe sizes 1 ½" and smaller. Combination strainers shall not be used at central air handling units.

3.03 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe. No pipe shall be dropped from cars or trucks, or allowed to roll down slides without proper retaining ropes. During transportation, each pipe shall rest on suitable pads, strips, skids or blocks securely wedged or tied in place. Any pipe damaged shall be replaced.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping.
Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
T. Install bronze strainers in copper piping systems and cast iron strainers in steel piping systems.
U. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
V. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
W. Install all temperature sensors and flow switches at the direction of the Building Automation System Contractor.
X. Install sleeves and mechanical sleeve seals per the requirements of Division 23 Section “Common Work Results for HVAC”.
Y. Install pressure-seal pipe and fittings per manufacturer’s most current installation guidelines.
Z. Install all condensate drain piping at a minimum slope of 1/8” per foot.

3.04 HANGERS AND SUPPORTS

A. Comply with requirements in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for pipe hanger and support products and installation.
    1. Vertical Piping: MSS Type 8 or 42, clamps.
    2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
    3. Multiple, Straight, Horizontal Piping Runs: Field fabricated, heavy duty trapeze. Fabricate from steel shapes required for loads.
B. Support vertical piping and tubing at base and at each floor.
C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
D. Install supports for vertical copper tubing every 10 feet.
E. Install supports for vertical steel piping every 15 feet.

F. Install hangers for horizontal piping with the following minimum rod sizes and maximum spacing for trapeze type hangers with multiple rise runs of varying sizes. The hangers shall be spaced based upon the smallest diameter pipe.

Nom. Pipe Size – Inches	Steel Pipe Max. Span – Ft.	Copper Tube Max. Span – Ft.	Min. Rod Dia. - Inches
Up to ¾	7	5	3/8
1	7	6	3/8
1-1/4	7	6	3/8
1-1/2	9	8	3/8
2	10	8	3/8
2-1/2	11	9	½
3	12	10	½
3-1/2	12	10	½
4	12	10	½
5	12	10	5/8
6	12	10	¾
8	12	10	7/8
10	12	10	7/8
12	12	10	7/8

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.05 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

3.06 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
F. Install diaphragm or bladder tanks expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
B. Install control valves in accessible locations close to connected equipment.
C. Control Valve Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to coordinate valve installation procedure. Pre-installation conference shall include the BAS contractor, piping contractor, commissioning agent, and Engineer. Agenda for meeting shall include but not be limited to the following:
    1. Review of submittals and control valve orientation.
    2. Review of control valve and equipment type.
    3. Sequence of construction, responsibilities and schedule for subsequent operations.
    4. Wiring and testing of installed control valve.
    5. System start-up procedure, including flushing of hydronic system.
D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.08 CHEMICAL TREATMENT

A. Provide the services of a chemical treatment consultant to perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics. Test the water at a minimum of four different sample points throughout the system as selected by the Engineer. Submit a report to the Engineer to include the initial water analysis and the consultants recommendations.
    1. pH: 8.0 to 10.0
    2. “P” Alkalinity: 100 to 500 ppm.
    3. Boron: 100 to 200 ppm.
    4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
    5. Corrosion Inhibitor:
        a. Sodium Nitrate: 1000 to 1500 ppm
    6. Soluble Copper: Maximum 0.20 ppm
    7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
    8. Total Suspended Solids: Maximum 10 ppm.
    9. Ammonia: Maximum 20 ppm.
    10. Free Caustic Alkalinity: Maximum 20 ppm.
    11. Microbiological Limits:
        a. Total Aerobic Plate Count: Maximum 1000 organisms/ml.
        b. Total Anaerobic Plate Count: Maximum 100 organisms/ml.
        c. Nitrate Reducers: 100 organisms/ml.
        d. Sulfate Reducers: Maximum 0 organisms/ml.
        e. Iron Bacteria: Maximum 0 organisms/ml.
    12. “Fe” Iron: Equal to make-up water.
    13. “PO4” Phosphate: Equal to make-up water.
    14. “TDS” Total Dissolved Solids: 1500-1750 ppm, (as $CaCO_3$)

B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, install new filter in the bypass feeder and refill with fresh water. Provide all additional valves, fitting, temporary piping, piping connections and pumps required to isolate sections of pipe intended to be cleaned and flushed from existing or previously cleaned and finished. Test for oil and grease and do not proceed until the oil and grease levels are within acceptable tolerances. Provide a water meter to measure the system fill volume as necessary to provide a basis for the quantity of chemicals or glycol required for the final fill of the system.

C. Service Period: Provide water treatment chemicals and service program for period of one year from start-up date of system, to maintain water quality in ranges note above, including the following:
   1. Initial water analysis and recommendations.
   2. Systems start-up assistance.
   3. Training of operating personnel.
   4. Periodic field service and consultation.
   5. Customer report charts and log sheets.
   6. Laboratory technical assistance.

D. Fill systems indicated to have glycol solutions with the following concentrations. Base the final fill volume on the metered water volume. Provide a plaque for installation in the boiler room that states the glycol manufacturer, type, and percentage for each system. For existing systems that are modified, remove the existing hydronic fluids and dispose in accordance with all local and State environmental requirements.
   1. Hybrid VRF Water System: Minimum 30 percent propylene glycol. Assume a quantity of 1000 gallons of pre-mixed glycol solution for bidding purposes (refer to part 2.0 for requirements). Base the final fill volume on the metered water volume. Provide a quantity of glycol adequate such that the Owner has extra stock equal to 55-gallons upon final closeout of the project.

E. For renovated systems, reclaim the existing glycol solution where new glycol is not indicated and store in containers on site in a location coordinated with the Owner. The chemical treatment consultant shall test the content and quality of the glycol solution for each system and submit a report to the engineer. Provide a temporary pump and filter assembly to filter the reclaimed glycol as it is reinstalled into the system.
   1. Hot Water Heating System: In addition to the reclaimed glycol, provide a minimum quantity of 1000 gallons of pre-mixed glycol solution for bidding purposes as necessary to achieve a minimum 30 percent propylene glycol solution (refer to part 2.0 for requirements). Provide a quantity of glycol such that the Owner has extra stock equal to 55 gallons upon final closeout of the project.

3.09 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
   5. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens and install new filter in the bypass feeder. Notify the Owner and Engineer one week prior to performing flushing procedures such that procedures can be witnessed.
   6. Prepare a written report of flushing procedures indicating the date of flushing and signed by the person performing the procedures validating it has been completed.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the maximum operating pressure, but no less than 100 psi. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing indicating the date of testing, the specific procedures and test pressures, and signed by the person performing the work. Submit the report to the Engineer.
   7. Provide at the Engineer's discretion a water quality test by an independent agency to validate flushing procedures have been completed and the chemical treatment has been completed to maintain water quality within the specified ranges.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup pressure-reducing valves for required system pressure.
   4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   5. Set temperature controls so all coils are calling for full flow.
   6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
   7. Verify lubrication of motors and bearings.
   8. Remove and clean or replace strainer screens and install new filter in the bypass feeder.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate and maintain hydronic piping systems. Refer to Division 01 Section "Demonstration and Training."
   1. Required Time: As required.

END OF SECTION 23 21 13

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.02 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:
   1. Suction Lines for Air-Conditioning Applications: 115 psig.
   2. Suction Lines for Heat-Pump Applications: 225 psig.
   3. Hot-Gas and Liquid Lines: 225 psig.

B. Line Test Pressure for Refrigerant R-407C:
   1. Suction Lines for Air-Conditioning Applications: 230 psig.
   2. Suction Lines for Heat-Pump Applications: 380 psig.
   3. Hot-Gas and Liquid Lines: 380 psig.

C. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig.
   2. Suction Lines for Heat-Pump Applications: 535 psig.
   3. Hot-Gas and Liquid Lines: 535 psig.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop Drawing Scale: 1/4 inch equals 1 foot.
   2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Provide indication of the quantity of refrigerant for each individual system. Provide a certificate of test for all systems containing 55 pounds or more of refrigerant. The certificate shall contain the name of the refrigerant and the field test pressure applied to the high side and low side of the system. The certification of test shall be signed by the installer and shall be made part of the Public Record.

1.04 CLOSEOUT DOCUMENTATION

A. Record Documents: Submit record documents in accordance with the requirements in Division 1 Section "Project Record Documents."

B. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".

C. Submit field quality control reports.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.06 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.07 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR, ASTM B88, Type L or K.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.02 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Copper spring.
   5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   1. Body and Bonnet: Plated steel.
   2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter. Solenoid valves shall be controlled directly from the unit's on-board factory controller. For bidding purposes, assume all solenoid valves will be 120-volt. Coordinate with unit manufacturer and field verify prior to installation as required to provide solenoid valve compatible with the factory controllers. Temperature controls contractor shall be responsible for all control wiring between the solenoid valves and factory controllers.
   6. Working Pressure Rating: 400 psig.
   7. Maximum Operating Temperature: 240 deg F.
   8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   2. Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Seat Disc: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Working Pressure Rating: 400 psig.
   6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   5. Suction Temperature: 40 deg F.
   6. Superheat: Adjustable.
   7. Reverse-flow option (for heat-pump applications).
   8. End Connections: Socket, flare, or threaded union.
   9. Working Pressure Rating: 700 psig.

H. Straight-Type Strainers:
   1. Body: Welded steel with corrosion-resistant coating.
   2. Screen: 100-mesh stainless steel.
   3. End Connections: Socket or flare.
   4. Working Pressure Rating: 500 psig.
   5. Maximum Operating Temperature: 275 deg F.

I. Moisture/Liquid Indicators:
   1. Body: Forged brass.
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in ppm.
   4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
   5. End Connections: Socket or flare.
   6. Working Pressure Rating: 500 psig.
   7. Maximum Operating Temperature: 240 deg F.

J. Replaceable-Core Filter Dryers: Comply with ARI 730.
   1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   3. Desiccant Media: Activated alumina.
   4. Designed for reverse flow (for heat-pump applications).
   5. End Connections: Socket.
   6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
   7. Working Pressure Rating: 500 psig.
   8. Maximum Operating Temperature: 240 deg F.

K. Receivers: Comply with ARI 495.
   1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   2. Comply with UL 207; listed and labeled by an NRTL.
   3. Body: Welded steel with corrosion-resistant coating.
   4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
   5. End Connections: Socket or threaded.
   6. Working Pressure Rating: 500 psig.
   7. Maximum Operating Temperature: 275 deg F.

L. Liquid Accumulators: Comply with ARI 495.
   1. Body: Welded steel with corrosion-resistant coating.
   2. End Connections: Socket or threaded.
   3. Working Pressure Rating: 500 psig.
   4. Maximum Operating Temperature: 275 deg F.

2.03 REFRIGERANTS

A. ASHRAE 34, R-134a: Tetrafluoroethane.

B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

A. Suction Lines NPS 1-1/2 and smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing or Type L drawn temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Hot-Gas and Liquid Lines:
   1. NPS 1-1/2: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
   2. NPS 2 to NPS 4: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

D. Safety-Relief-Valve Discharge Piping: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

D. Install a full-sized, three-valve bypass around filter dryers.

E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

F. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
G. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.
J. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
K. Install receivers sized to accommodate pump-down charge where recommended by the equipment manufacturer.
L. Install flexible connectors at compressors.

3.03 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
B. Install refrigerant piping according to ASHRAE 15.
C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping adjacent to machines to allow service and maintenance.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Select system components with pressure rating equal to or greater than system operating pressure.
J. Refer to Division 23 Sections "Building Automation System" and "BAS Sequence of Operations" for solenoid valve controllers, control wiring, and sequence of operation.
K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Panels" if valves or equipment requiring maintenance is concealed behind finished surfaces.
M. Install refrigerant piping in protective conduit where installed belowground.
N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

S. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

T. Install sleeves and mechanical sleeve seals per the requirements of Division 23 Section “Common Work Results for HVAC”.

3.04 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.05 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

Nom. Pipe Size – Inches	Copper Tube Max. Span – Ft.	Min. Rod Dia. – Inches
½	5	¼
5/8	5	¼
1	6	¼
1¼	8	3/8
1½	8	3/8
2	8	3/8
2½	9	3/8
3	10	3/8
4	12	½

D. Support multifloor vertical runs at least at each floor.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.07 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

3.09 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate and maintain refrigerant piping systems. Refer to Division 01 Section “Demonstration and Training.”

1. Required Time: As required.

END OF SECTION 23 23 00

SECTION 23 31 13
DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes duct and fitting materials, joining methods, and specialties for the following:
   1. Metal ducts
   2. Flexible ducts

1.02 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated. Closure systems shall comply with their applicable UL 181 label and listing.
   1. Static-Pressure Classes:
      a. Supply Ducts (non-variable air volume systems): 2-inch.
      b. Supply Ducts (Upstream from Air Terminal Units): 3 inch.
      c. Supply Ducts (Downstream from Air Terminal Units): 1 inch.
      d. Return Ducts (Negative Pressure): 1-inch wg.
      e. Exhaust Ducts (Negative Pressure): 1-inch wg.
      f. Outside Air Ducts (Negative Pressure): 2-inch wg.
      g. Relief Ducts (Positive Pressure): 1-inch wg.
   2. Refer to “PART 3: EXECUTION” for duct leakage testing requirements based on the static pressure classes listed above.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated.
B. Shop Drawings
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Reinforcement and spacing.
   7. Seam and joint construction.
   8. Penetrations through fire-rated and other partitions.
   9. Equipment installation based on equipment being used on Project.
   10. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
   11. Hangers and supports, including methods for duct and building attachment and vibration isolation.
C. Field quality-control reports.

1.04 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
B. Submit field quality control reports.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
B. Leakage Tests: Perform tests as directed by the Testing Agent and submit reports.

PART 2 PRODUCTS

2.01 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Finishes for surfaces exposed to View only when shown to be painted on architectural plans: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

2.02 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.04 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity:
      a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. 75 deg F mean temperature.
      b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. 75 deg F mean temperature.
   2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
      b. Intervals of lined duct preceding unlined duct.
      c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
   8. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.05 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Closure systems shall comply with their applicable UL 181 label and listing.

C. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches.
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

D. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920
   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.
   5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.06 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation. Swimming pool areas shall utilize Type 304L or Type 316L stainless steel for all rods, fasteners, hardware, and supports.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Swimming pool areas shall utilize Type 304L or Type 316L stainless steel materials for duct attachments.

H. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate. Swimming pool areas shall utilize Type 304L or Type 316L stainless steel for all trapeze and riser supports.

PART 3 EXECUTION

3.01 DUCT APPLICATIONS

A. Fabricate ducts with galvanized sheet steel.
B. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel.
   2. Stainless-Steel Ducts: Galvanized steel.
   3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.
C. Liner (all transfer air ducts and as noted on the plans):
   1. Supply- and Return-Air Ducts: Fibrous glass, Type I, 1 inch thick where noted on the plans.
   2. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.
D. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
      a. Velocity 1000 fpm or Lower
         1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         2) Mitered Type RE 4 without vanes.
      b. Velocity 1000 to 1500 fpm:
         1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
         3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
      c. Velocity 1500 fpm or Higher:
         1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
         3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
   2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
      a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
         1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
         2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
         3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
      c. Round Elbows, 14 Inches and Larger in Diameter: Welded.
E. Branch Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
      a. Rectangular Main to Rectangular Branch: 45-degree entry.
      b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
    a. Velocity 1000 fpm or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm: Conical tap.
    c. Velocity 1500 fpm or Higher: 45-degree lateral.

3.02 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated or smoke-rated interior partitions and exterior walls, install fire or fire/smoke dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers. Provide firestopping material as required to maintain fire rating and smoke rating. Comply with all firestopping manufacturer’s installation guidelines.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's “Duct Cleanliness for New Construction Guidelines Advanced Cleanliness Level.”

M. Install duct smoke detectors furnished by Division 26.

N. Install control dampers furnished by others. Coordinate the installation with the Section 23 09 00 and 23 09 93 Contractor.

3.03 SEAM, JOINT AND CONNECTIONS SEALING

A. All longitudinal and transverse joints, seams, and connections in metallic and non-metallic ducts shall be constructed as specified in SMACNA HVAC Duct Construction Standards – Metal and Flexible and NAIMA Fibrous Glass Duct Construction Standards. All joints, longitudinal and transverse seams, and connections in ductwork shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, liquid sealants, or tapes. Closure systems used to seal ductwork listed and labeled in accordance with UL 181A shall be marked “181A-P” for pressure-sensitive tape, “181A-M” for mastic or “181A-H” for heat-sensitive tape. Closure systems used to seal flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked “181B-FX” for pressure-sensitive tape or “181B-M” for mastic. Duct connections to flanges of air distribution system equipment shall be sealed and mechanically fastened. Mechanical fasteners for use with flexible nonmetallic air ducts shall comply with UL 181B and shall be marked “181B-C”. Closure systems used to seal metal ductwork shall be installed in accordance with the manufacturer’s installation instructions. Pressure-sensitive tape shall not be used as primary sealant on ducts, unless it has been certified to comply with UL 181A or UL 181B by a nationally recognized testing laboratory and the tape is used in accordance with certification. Unlisted duct tape is not permitted as a sealant on any duct.

1. Exception: Continuously welded and locking-type longitudinal joints and seams in ducts operating at static pressures less than 2 inches of water column pressure classification shall not require additional closure systems.

3.04 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

G. Hangers shall not be attached to metal roof deck.

3.05 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.07 FIELD QUALITY CONTROL

A. Duct leakage test:

1. Test the following systems (refer to paragraph 1.02.A.1 for pressure class designations):
   a. Ductwork in pressure classes 2-inch and greater.
   b. All ductwork located outside.
2. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Test representative sections totaling no less than 25% of the total installed duct area. All sections shall be selected by the Owner’s designated representative.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before insulation application.
5. Conduct tests at static pressures equal to maximum design pressure class of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
6. Leakage Rates shall be a maximum rate as follows:
   a. Round and flat-oval sheetmetal ducts:
      1) 1-inch pressure class 3.0 CFM/100 sq.ft.
      2) 2-inch pressure class 4.8 CFM/100 sq.ft.

3) 3-inch pressure class 6.2 CFM/100 sq.ft.
4) 6-inch pressure class 9.7 CFM/100 sq.ft.
5) 8-inch pressure class 11.6 CFM/100 sq.ft.

b. Rectangular sheetmetal ducts:
1) 1-inch pressure class 6.0 CFM/100 sq.ft.
2) 2-inch pressure class 9.5 CFM/100 sq.ft.
3) 3-inch pressure class 12.3 CFM/100 sq.ft.
4) 6-inch pressure class 19.3 CFM/100 sq.ft.
5) 8-inch pressure class 23.2 CFM/100 sq.ft.

c. Round flexible ducts:
1) 1-inch pressure class 6.0 CFM/100 sq.ft.
2) 2-inch pressure class 9.5 CFM/100 sq.ft.

B. Duct system will be considered defective if it does not pass tests and inspections. Defective duct systems shall be disassembled, reassembled, and sealed as required for compliance with the test requirements. If initial duct leakage tests fail, the Engineer may require, at the expense of the Contractor, additional testing up to 100 percent of all ductwork in all pressure classes.

C. Prepare test and inspection reports.

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate and maintain ductwork systems. Refer to Division 01 Section "Demonstration and Training."

1. Required Time: As required.

END OF SECTION 23 31 13

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: These should be linked to part 2 and part 3 to turn off if not selected to be included
   1. Manual volume dampers.
   2. Backdraft and pressure relief dampers.
   3. Fire dampers.
   4. Ceiling dampers.
   5. Smoke dampers.
   6. Combination fire and smoke dampers.
   7. Turning vanes.
   8. Remote damper operators.
   9. Duct-mounted access doors.
   10. Flexible connectors.
   11. Flexible ducts.
   12. Duct accessory hardware

1.02 SUBMITTALS

A. Provide product data for each type of product indicated.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

1.03 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
B. Submit field quality control reports.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
B. Comply with AMCA 500-D testing for damper rating.

1.05 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.
   2. Fire Dampers: Provide material and installation costs for eight extra fire dampers. Assume a damper size of 8 x 12. Damper sizes are to be field verified at locations required and ordered only after approval from the Engineer.
   3. Combination Fire/Smoke Damper: Provide material and installation costs for two extra fire/smoke dampers. Assume a damper size of 8 x 12. Damper sizes are to be field verified at locations required and ordered only after approval from the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Exposed-Surface Finish: Mill phosphatized.
C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Standard leakage rating.
   2. Suitable for horizontal or vertical applications.
   3. Frames:
      a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   4. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized-steel, 0.064 inch thick.
   5. Blade Axles: Galvanized steel.
   6. Bearings:
      a. Oil-impregnated bronze or Molded synthetic.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   7. Tie Bars and Brackets: Galvanized steel.
   8. Locking Device: Device capable of holding the single blade damper in a fixed position without vibration.

B. Standard, Aluminum, Manual Volume Dampers:
   1. Standard leakage rating.
   2. Suitable for horizontal or vertical applications.
   3. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
   4. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
   5. Blade Axles: Stainless steel or Nonferrous metal.
   6. Bearings:
      a. Oil-impregnated bronze or Molded synthetic.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   7. Tie Bars and Brackets: Aluminum.
   8. Locking Device: Device capable of holding the single blade damper in a fixed position without vibration.

C. Jackshaft:
   1. Size: 1-inch diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:
   1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
   2. Include center hole to suit damper operating-rod size.
   3. Include elevated platform for insulated duct mounting.

2.03 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Description: Gravity balanced.
B. Maximum Air Velocity: 2000 fpm.
C. Maximum System Pressure: 2-inch wg.
D. Frame: 0.063-inch- thick extruded aluminum, with welded corners and mounting flange.
E. Blades: Multiple single-piece blades, maximum 6-inch width, 0.050-inch- thick aluminum sheet with sealed edges.
F. Blade Action: Parallel.
G. Blade Seals: Extruded vinyl, mechanically locked or Neoprene, mechanically locked.
H. Blade Axles:
   1. Material: Aluminum.
   2. Diameter: 0.20 inch.
I. Tie Bars and Brackets: Aluminum.
J. Return Spring: Adjustable tension.
K. Bearings: Steel ball or synthetic pivot bushings.
L. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
   3. Electric actuators.
   4. Chain pulls.
   5. Front of rear screens.
   6. 90-degree stops.
M. Sleeve: Minimum 20-gage thickness.
N. Non-motorized gravity backdraft dampers for exhaust and relief air applications shall meet one of the following requirements:
   1. Dampers shall have a maximum air leakage rate of 20 cfm/sq.ft. where not less than 24-inches in either dimension when tested at 1.0-inches water gauge in accordance with AMCA 500-D for such purpose.
   2. Dampers shall have a maximum air leakage rate of 40 cfm/sq.ft. where less than 24-inches in either dimension when tested at 1.0-inches water gauge in accordance with AMCA 500-D for such purpose.
   3. Dampers 8-inches in diameter or smaller shall be spring-loaded and a weather hood at the point of discharge.

2.04 FIRE DAMPERS

A. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
B. Closure Rating:
   1. Velocity:
      a. Vertical mount, less than 24"x24": 4,000 fpm minimum.
      b. Horizontal mount, less than 24"x24": 3,000 fpm minimum.
      c. Vertical or horizontal mount, 24"x24" and larger: 2,000 fpm minimum.
   2. Pressure: 4-inch w.g. static pressure on all sizes and mounting orientations.
   3. Dampers closure ratings shall apply to airflow movement in either direction.
C. Fire Rating: Provide 1½ hour rated dampers unless indicated to be 3 hour on the drawings.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners. Provide Type 304, stainless steel construction for dampers in corrosive environments including all installations within aluminum duct or PVC coated construction. Confirm damper sizes and configuration prior to ordering dampers. Show all locations on the coordination drawings as required in Section 23 05 00.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel. Provide Type 304 construction where dampers are stainless steel.
   1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links unless higher rating is indicated on the drawings.

J. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F rated.

2.05 CEILING DAMPERS

A. General Requirements:
   1. Labeled according to UL 555C by an NRTL.
   2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

B. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

C. Blades: Galvanized sheet steel with refractory insulation.

D. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links unless otherwise indicated on the drawings.

E. Fire Rating: 2 hour unless otherwise indicated on the drawings to match ceiling system.

2.06 SMOKE DAMPERS

A. General Requirements: Label according to UL 555S by an NRTL.

B. Duct smoke detectors supplied by Division 26 and installed by this contractor.

C. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

D. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

E. Leakage: Class I unless otherwise indicated to be Class II on the drawings.

F. Rated pressure and velocity to exceed design airflow conditions.

G. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

H. Damper Motors: Two-position action.

I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Building Automation System."
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

J. Accessories:
1. Test and reset switches.

2.07 COMBINATION FIRE AND SMOKE DAMPERS

A. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
B. Closure Rating:
1. Velocity:
a. Vertical mount, less than 24"x24": 4,000 fpm minimum.
b. Horizontal mount, less than 24"x24": 3,000 fpm minimum.
c. Vertical or horizontal mount, 24"x24" and larger: 2,000 fpm minimum.
2. Pressure: 4-inch w.g. static pressure on all sizes and mounting orientations.
3. Dampers closure ratings shall apply to airflow movement in either direction.
C. Fire Rating: 1-1/2 hours unless otherwise indicated on the drawings.
D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners. Provide Type 304, stainless steel construction for dampers in corrosive environments including all installations within aluminum duct or PVC coated construction. Confirm damper sizes and configuration prior to ordering dampers. Show all locations on the coordination drawings as required in Section 23 05 00.
E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links unless otherwise indicated on the drawings.
F. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
G. Duct smoke detectors supplied under Division 26 and installed by this contractor.
H. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
I. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
J. Leakage: Class I unless indicated to be Class II on the drawings.
K. Rated pressure and velocity to exceed design airflow conditions.
L. Damper Motors: Two-position action.
M. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking. Provide with Type 304 stainless steel sleeves where stainless steel dampers are indicated.
N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Building Automation System."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

O. Accessories:
1. Test and reset switches.

2.08 TURNING VANES

A. Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

C. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.09 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

B. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 DUCT ACCESS PANEL ASSEMBLIES

A. Labeled according to UL 1978 by an NRTL for fire rated duct systems including kitchen exhaust systems.

B. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

C. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

E. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.11 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 FLEXIBLE DUCTS

A. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.

B. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.13 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
    1. Coordinate subparagraphs below with Division 23 Section "Metal Ducts." Install steel volume dampers in steel ducts.
    2. Install aluminum volume dampers in aluminum ducts.
E. Set dampers to fully open position before testing, adjusting, and balancing.
F. Install test holes at fan inlets and outlets and elsewhere as indicated.
G. Install fire and smoke dampers according to UL listing.
H. Install smoke damper test switches and auxiliary switches in accordance with manufacturer's instructions. Coordinate final connections with the Electrical contractor.
I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
    1. On both sides of duct coils.
    2. Downstream from manual volume dampers, control dampers, turning vanes, and equipment.
    3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
    4. At each change in direction and at maximum 50-foot spacing.
    5. Upstream of turning vanes.
    6. Elsewhere as indicated.
J. Install access doors with swing against duct static pressure.
K. Access Door Sizes:
    1. One-Hand or Inspection Access: 8 by 5 inches.
    2. Two-Hand Access: 12 by 6 inches.
    3. Head and Hand Access: 18 by 10 inches.
    4. Head and Shoulders Access: 21 by 14 inches.
    5. Body Access: 25 by 14 inches.
    6. Body plus Ladder Access: 25 by 17 inches.
L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
M. Install flexible connectors to connect ducts to equipment.
N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
O. Connect diffusers to low-pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped with stainless steel tightening band.
P. Connect flexible ducts to metal ducts with stainless steel tightening band.
Q. Install duct test holes where required for testing and balancing purposes.
R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
S. Install duct smoke detectors furnished by Division 26.
T. Install control dampers furnished by others. Coordinate the installation with the Section 23 09 00 and 23 09 93 Contractor.

3.02 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

3.03 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate and maintain air duct accessories. Refer to Division 01 Section "Demonstration and Training."

1. Required Time: 2 hours.

END OF SECTION 23 33 00

SECTION 23 34 16
AIR HANDLING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. In-line centrifugal fans.

1.02 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.
B. Operating Limits: Classify according to AMCA 99.

1.03 SUBMITTALS

A. Provide product data for each type of product indicated. Include rated capacities, furnished specialties, controllers, and accessories for each type of product indicated. Include certified fan performance curves with system operating conditions indicated. Include certified fan sound-power ratings. Include motor ratings and electrical characteristics, plus motor and electrical accessories. Include dampers, including housings, linkages, and operators. Include detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.04 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".
B. Submit field quality control reports.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
D. UL Standard: Power ventilators shall comply with UL 705.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
C. Lift and support units with manufacturer's designated lifting or supporting points.

1.07 COORDINATION

A. Coordinate size and location of structural-steel support members.
B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set(s) for each belt-driven unit.
B. Furnish replacement drives and sheaves for each type of fan in quantity greater than one and not less than 20% of the total number of each fan type. Exact sizes provided shall be at the direction of the Testing and Balancing Contractor as required to achieve design air flows. Labor for installation is specified in Part 3 of this section.
C. Furnish replacement motors for each type of fan in a quantity greater than one and not less than 20% of the total number of each fan type. Exact motor hp shall be at the direction of the Testing and Balancing Contractor as required to achieve design air flows. Assume for the purposes of bidding that each fan motor will increase a maximum of one hp size. Labor for installation is specified in Part 3 of this section.

PART 2 PRODUCTS

2.01 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Ammerman; General Resource Corp.
   3. Captive Aire
   4. Greenheck.
   5. Hartzell Fan, Inc.
   6. JencoFan; Div. of Breidert Air Products.
   7. Loren Cook Company.
   8. Penn Ventilation.
   9. Twin City Fan

B. Description: In-line, direct or belt-driven centrifugal fans as indicated on the drawings, consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing. Provide ECM motors where noted on the drawings.

E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

G. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent. Provide on all direct drive fans and as noted on the drawings.
   2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   3. Companion Flanges: For inlet and outlet duct connections.
   4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
   6. Vibration Isolators: Elastomeric hangers.

2.02 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment", including, but not limited to, efficiency ad power factor correction requirements.

B. Enclosure Type: Totally enclosed, fan cooled.

C. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

2.03 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 EXECUTION

3.01 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using elastomeric mounts, restrained elastomeric mounts, spring isolators or restrained spring isolators having a static deflection of 1 inch.

C. Support suspended units from structure using threaded steel rods and elastomeric hangers or spring hangers as specified having a static deflection of 1 inch.

D. Install units with clearances for service and maintenance.
E. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
B. Install ducts adjacent to power ventilators to allow service and maintenance.
C. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   10. Shut unit down and reconnect automatic temperature-control operators.
   11. Remove and replace malfunctioning units and retest as specified above.
B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Adjust belt tension.
C. Refer to Division 23 Section "Testing, Adjusting, and Balancing " for testing, adjusting, and balancing procedures.
D. Replace fan and motor pulleys as required to achieve design airflow.
E. Lubricate bearings.

3.05 PROJECT CLOSEOUT

A. Replace fan drives and sheaves as directed by the Engineer as required for systems to perform to the intended design conditions. The Contractor’s bid shall include labor and materials required to replace the quantity of drives and sheaves specified in Part 1.0 “Extra Materials”.
B. Replace fan motors as directed by the Engineer as required for systems to perform to the intended design conditions. The Contractor’s bid shall include all material and labor required to replace the quantity at motors, specified in Part 1.0 “Extra Materials”.

3.06 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate and maintain air handling equipment. Refer to Division 01 Section “Demonstration and Training.”
   1. Required Time: 2 hours.

END OF SECTION 23 34 16

SECTION 23 37 13
DIFFUSERS REGISTERS AND GRILLES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Air diffusers.
   2. Registers and grilles.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings. Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the manufacturers specified:
   1. Anemostat
   2. arnes
   3. Krueger
   4. Titus
   5. Metalaire
   6. Nailor
   7. Price
   8. Tuttle and Bailey

2.02 AIR DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule. The following requirements shall apply to nomenclature indicated on schedule:
   1. Diffuser Faces:
      a. Round: Round housing, core of concentric rings, round duct connection.
      b. Square: Square housing, core of square concentric louvers, square or round duct connection.
      c. Linear: Extruded aluminum continuous slot, single or multiple.
   2. Diffuser Mountings:
      a. Lay-in: Diffuser housing sized to fit between ceiling exposed suspension tee bars and rest on top surface of tee bar.
      b. Duct-mounted.
   3. Diffuser Patterns:
      a. Fixed: Fixed position core with concentric rings or louvers for radial air flow around entire perimeter of diffuser.
      b. Adjustable: Manual adjustable core with concentric rings or louvers, fully adjustable for horizontal to vertical air flow.
   4. Diffuser Dampers:
      a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of diffuser.
      b. Integral: Combination volume control and pattern adjustment for linear diffusers.

5. Diffuser Accessories:
    a. Equalizing Deflectors: Adjustable parallel blades in frame for straightening air flow.
    b. Blank-Off Baffles: Arc segments designed to fit into diffuser housing to divert air flow from impinging on obstruction, and to create directional pattern.
    c. Operating Keys: Tools designed to fit through diffuser face and operate volume control device and/or pattern adjustment.
6. Diffuser Finishes:
    a. White Enamel: Semi-gloss white enamel prime finish.

2.03 REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide wall registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule. The following requirements shall apply to nomenclature indicated on schedule:
1. Register and Grille Materials:
    a. Steel Construction (ST): Manufacturer's standard stamped sheet steel frame and adjustable blades.
    b. Aluminum Construction (AL): Manufacturer's standard extruded aluminum frame and adjustable blades.
2. Register and Grille Faces:
    a. Horizontal Straight Blades: Horizontal blades, individually adjustable, at manufacturer's standard spacing.
    b. Vertical Straight Blades: Vertical blades, individually adjustable, at manufacturer's standard spacing.
    c. Horizontal 45o Fixed Blades: Horizontal blades, fixed at 45o, at manufacturer's standard spacing.
3. Register and Grille Patterns:
    a. Single Deflection: 1 set of blades in face.
    b. Double Deflection: 2 sets of blades in face, rear set at 90o to face set.
4. Register and Grille Dampers:
    a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of register.
5. Register and Grille Accessories:
    a. Operating Keys: Tools designed to fit through register or grille face and operate volume control device and/or pattern adjustment.
6. Register and Grille Finishes:
    a. White Enamel: Semi-gloss white enamel prime finish.

2.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, “Method of Testing for Rating the Performance of Air Outlets and Inlets.”

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 37 23
HVAC GRAVITY VENTILATORS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following types of roof-mounting intake and relief ventilators:
   1. Roof hoods.
   2. Goosenecks.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure. Include details, drawn to scale and coordinated based on input from installers, of the items involving structural members to which roof curbs and ventilators will be attached and sizes and locations of roof openings.
B. Provide chart of manufacturers standard color options for selection by the Architect.

1.03 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain ventilators through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of intake and relief ventilators and are based on the specific equipment indicated. Refer to Division 01 Section "Substitutions and Product Options."
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.05 COORDINATION

A. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.01 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.
D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.
E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use Phillips flat-head screws for exposed fasteners, unless otherwise indicated.
F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.02 FABRICATION, GENERAL

A. Factory or shop fabricate intake and relief ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
D. Fabricate supports, anchorages, and accessories required for complete assembly.
E. Perform shop welding by AWS-certified procedures and personnel.

2.03 ROOF HOODS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Aerovent; a Twin City Fan company.
   3. Carnes.
   4. Greenheck.
   5. Loren Cook Company.
   6. Penn Ventilation.
   7. Ruskin.
B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.
C. Materials: Galvanized-steel sheet, minimum 0.064-inch-thick base and 0.040-inch-thick hood; suitably reinforced.
D. Bird Screening: Galvanized-steel, 1/2-inch- square mesh, 0.041-inch wire.
E. Galvanized-Steel Sheet Finish:
   1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
   2. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
      a. Color and Gloss: As selected by Architect from manufacturer's full range.
F. Roof Curbs: Galvanized steel, mitered and welded corners, 1-1/2-inch wood nailer, and in compliance with NRCA standards. Size as required to suit roof opening and fan base.
   1. Insulation (MN): Minimum R-10 insulation value, either rigid fiberglass or flexible elastomeric, adhered to inside walls. Provide custom fabricated curb as may be necessary to meet insulation criteria.
   2. Configuration: Self-flashing without a cant strip, with mounting flange or built-in raised cant and mounting flange as required for roofing type.
   3. Overall Height: 24 inches unless otherwise noted on plans.
   4. Metal Liner: Galvanized steel.
   5. Pitch Mounting: Manufacture curb for roof slope.

2.04 GOOSENECKS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 5-5; with a minimum of 0.052-inch- thick, galvanized-steel sheet.
B. Bird Screening: Galvanized-steel, 1/2-inch- square mesh, 0.041-inch wire.
C. Galvanized-Steel Sheet Finish:
   1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
   2. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
      a. Color and Gloss: As selected by Architect from manufacturer's full range.

D. Roof Curbs: Galvanized steel, mitered and welded corners, 1-1/2-inch wood nailer, and in compliance with NRCA standards. Size as required to suit roof opening and fan base.
   1. Insulation (MN): Minimum R-10 insulation value, either rigid fiberglass or flexible elastomeric, adhered to inside walls. Provide custom fabricated curb as may be necessary to meet insulation criteria.
   2. Configuration: Self-flashing without a cant strip, with mounting flange or built-in raised cant and mounting flange as required for roofing type.
   3. Overall Height: 24 inches unless otherwise noted on plans.
   4. Metal Liner: Galvanized steel.
   5. Pitch Mounting: Manufacture curb for roof slope.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install intake and relief ventilators level, plumb, and at indicated alignment with adjacent work.
B. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.
C. Install intake and relief ventilators with clearances for service and maintenance.
D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.
F. Label intake and relief ventilators according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

3.03 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 23 37 23

SECTION 23 62 00
PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes air-cooled condensing units.

1.02 SUBMITTALS

A. Product Data: For each condensing unit, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For condensing units to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.03 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of condensing units and are based on the specific system indicated. Refer to Division 01 Section "Substitutions and Product Options."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

1.04 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

C. Coordinate location of piping and electrical rough-ins.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Compressor failure.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONDENSING UNITS, AIR COOLED, 6 TO 120 TONS

A. Manufacturers:

1. Carrier Corporation; Carrier Air Conditioning Div.
2. McQuay International.
3. Trane Co. (The); Worldwide Applied Systems Group.
4. York International Corp.

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic or semihermetic compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

1. Capacity Control: Hot-gas bypass where indicated on plans and for all units 7.5 tons and larger.

D. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

E. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:
   1. Permanently lubricated ball-bearing motors.
   2. Separate motor for each fan.
   3. Dynamically and statically balanced fan assemblies.

F. Operating and safety controls include the following:
   1. Manual-reset, high-pressure cutout switches.
   2. Automatic-reset, low-pressure cutout switches.
   3. Low oil pressure cutout switch.
   4. Compressor-winding thermostat cutout switch.
   5. Three-leg, compressor-overload protection.
   6. Control transformer.
   7. Magnetic contactors for compressor and condenser fan motors.
   8. Timer to prevent excessive compressor cycling.
   9. Hot gas by-pass kit.

G. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:
   1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
   2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
   3. Gasketed control panel door.
   4. Condenser coil hail guard to protect coil from physical damage.

H. Electrical Connection:
   1. Non-fused disconnect switch, factory mounted and wired, for single external electrical power connection.
   2. The short circuit current rating (SCCR) shall be not less than 65K unless otherwise noted on the drawings. The SCR rating shall be published in accordance with UL508.

I. Accessories:
   1. Electronic programmable thermostat to control condensing unit and evaporator fan.
   2. Low Ambient Controller: To permit operation down to 0 deg F with time-delay relay to bypass low-pressure switch.
   3. Low Ambient Controller: Controls condenser fan speed to permit operation down to minus 20 deg F with time-delay relay to bypass low-pressure switch.
   4. Cottonwood Screens: Permatron BHC12 honeycomb weave black 12 mil polypropylene fiber mesh. Each fiber mesh panel shall be framed with a 1 ¼" sewn vinyl edge with double stitching. Each panel shall be secured with durable quick-release nylon twist lock fasteners. Screens shall be installed to cover all potential condenser coil air intakes to prevent debris from entering condenser coils. Screens shall be field installed by chiller supplier.

2.03 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment", including but not limited to, efficiency and power factor correction requirements.
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate condensing units according to ARI 210/240 for units less than 135,000 Btu/h and ARI 340/360 for units 135,000 Btu/h and larger.
   1. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings"/IECC
B. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
C. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of condensing units.
B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
C. Examine walls, floors, and roofs for suitable conditions where condensing units will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
B. Install condensing units on concrete base where indicated. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
C. Install roof-mounting units on equipment supports where indicated. Roof supports are specified in Division 07 and in architectural details of construction. Provide lag bolt with gasketed washer to fasten mechanical unit to curb. Also refer to manufacturer’s installation instructions.
D. Vibration Isolation: Install roof mounted condensing units on restrained spring isolators as recommended by the manufacturer.
E. Maintain manufacturer's recommended clearances for service and maintenance.
F. Install cottonwood screens to cover all potential air intakes to condenser coil.
G. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.
H. Provide a certificate of test for refrigerant piping systems with 55 pounds of refrigerant or more. Refer to specification section 23 23 00 Refrigerant Piping.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping."

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform electrical test and visual and mechanical inspection.
   2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.
B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
C. Remove and replace malfunctioning condensing units and retest as specified above.

3.05 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Inspect for physical damage to unit casing.
   2. Verify that access doors move freely and are weathertight.
   3. Clean units and inspect for construction debris.
   4. Verify that all bolts and screws are tight.
   5. Adjust vibration isolation and flexible connections.
   6. Verify that controls are connected and operational.

B. Lubricate bearings on fans.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings[and adjust belt tension].

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 62 00

SECTION 23 73 13
CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes constant-volume and variable volume, factory fabricated, double wall, central-station air-handling units for indoor and outdoor installations.

1.02 SUBMITTALS

A. Product Data: For each air-handling unit indicated.
   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. AMCA 210 certified fan-performance curves with system operating conditions indicated.
      b. AMCA 301 certified fan-sound power ratings at each octave band.
      c. Fan construction details and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Coils:
      a. AHRI 410 certified coil-performance ratings at the system operating conditions indicated.
      b. Support frame details to include materials of construction.
      c. Condensate drain pan and trap details to include materials of construction.
   5. Dampers, including housings, linkages, and operators.
   6. Air filters with performance characteristics and mounting frame details.
   7. Energy recovery devices with certified performance ratings at the operating conditions specified.
   8. Accessories as indicated.

B. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.

C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
   2. Support location, type, and weight.
   3. Field measurements.

D. Field quality control test reports specified in Part 3 of this Section.

E. Maintenance data for central-station air-handling units for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section 23 05 00 Common Work Results for HVAC.

1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled by a testing agency as defined in NFPA 70 and marked for intended location and application. Electrical components shall be acceptable to authorities having jurisdiction. Unit shall carry the ETL or UL sticker and certification.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. AMCA Compliance: Comply with AMCA Standard 210-16 “Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating”, and AMCA Standard 301-14, Methods for Calculating Fan Sound Ratings from Laboratory Test Data”

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2016, Section 5 – “Systems and Equipment” and Section 7 – “Construction and Startup.”

E. ASHRAE 90.1-2010 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2010, Section 6 – “Heating, Ventilating, and Air Conditioning.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project site factory-assembled in the largest practical sizes (to the extent allowable by shipping limitations). Ship products with 12 mil poly shrink-wrap.

B. Store in a clean, dry place. Protect from physical damage, water and moisture penetration, corrosion and general construction dirt and debris. Use extraordinary means to assure the units are turned over to the Owner in like-new condition without damage from shipping, storing or handling. Fans shall be rotated every two weeks by Contractor to minimize damage to the fan and motor bearings.

C. Lift and support units with the manufacturer's designated lifting or supporting points.

D. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

E. Deliver central-station air-handling unit's factory-assembled to the extent allowable by shipping limitations, with protective crating and covering.

1.05 COORDINATION

A. Coordinate sizes and location of concrete bases with actual equipment provided.

B. Coordinate size and location of structural-steel support members, if any, with actual equipment provided.

1.06 EXTRA MATERIALS

A. Furnish one additional complete set of belts for each belt driven fan.

B. Provide a minimum of three sets of both pre and final filters for each unit. One set shall be installed during temporary operation. Monitor filter dust and debris build-up and replace as needed such that the total pressure drop across the filter bank does not exceed 1.0 in w.c. Install a clean set of both pre and final filters just prior to system balancing. Coordinate scheduling with the Test and Balance Contractor to ensure that new filters are installed when Test and Balance work begins. Deliver to the Owner all remaining filters. A minimum of one set of both pre and final filters shall be turned over. Obtain a receipt from the Owner that new filters have been installed and the quantity of additional filters that have been turned over.

C. Furnish replacement pulleys and sheaves for each type of fan in a quantity greater than one and not less than 20% of the total number of each fan type. Exact sizes provided shall be at the direction of the Testing and Balancing Contractor as required to achieve design air flows.

D. Furnish replacement motors for each in a quantity greater than one and not less than 20% of the total number of motors. Exact motor hp shall be at the direction of the Testing and Balancing Contractor as required to achieve design air flows. Assume for the purposes of bidding that each fan motor will increase a maximum of one hp size.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include the following

1. Modular Air Handling Units
    a. Carrier Air Conditioning
    b. Daikin
    c. Johnson Controls
    d. The Trane Co.

2.02 MODULAR AIR HANDLING UNITS

A. Modular air handling units shall be factory engineered and assembled to comply with all requirements here-in. Units shall consist of casings, internally isolated fans, motor and drive assembly, heating and cooling coils, condensate drain pans, energy recovery wheels, access and plenum sections, filters and mounting frames, mixing dampers, airflow stations, and accessories.

1. Units shall be of the sizes, types, arrangements and capacities as indicated on the Drawings, Details, and Schedules.
2. Unit dimensions shall be as indicated on the Drawings and Details with allowances made for minor variations in manufacturing methods. General:

B. Base Rail and Floor:
   1. Provide a structural base rail under the full perimeter of the unit. The base rail shall be welded structural steel.
   2. Provide clearance for proper external trapping of the condensate drain pans.
   3. Provide base rail and lifting lug system that does not require additional support for rigging. Include base rail lifting lugs at the unit corners.
   4. Provide an additional .125" aluminum diamond tread plate floor liner in access areas.

C. Casing:
   1. Materials and Construction:
      a. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13. Insulation shall have a maximum Flame Spread of zero (0) under ASTM E 84. The panel assembly shall be UL listed and comply with all NFPA requirements. The inner liner shall be solid G90 galvanized steel.
      b. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
      c. Unit casing leakage rate shall not exceed 0.5 cfm per square foot of cabinet area at 5 inches of positive static pressure or 6 inches of negative static pressure.
      d. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
      e. Fabricated to allow removal for access to internal parts and components.
      f. Access panels and doors shall be constructed of the same materials and finishes as cabinet and complete with hinges, latches, handles, and gaskets. Each section shall have inspection and access panels and doors sized and located to allow periodic maintenance and inspections.
      g. Provide a fan access door wide enough to remove the motor and fan wheel but not less than 24" wide.

D. Fans, Motor, Drive Section:
   1. Provide direct or belt drive fans as indicated on the equipment schedules. The fan assembly shall be factory installed inside unit casings on vibration isolation springs and structural C-channel steel bases. Fans shall be selected for stable operation at both 100% of design airflow at design static pressure, and at 50% of design airflow at 25% of the design static pressure. In no case shall a fan be selected at more than 85% of peak design static pressure. In direct-drive applications the motors shall be selected as close to the synchronous speed of the motor as possible. All fan wheels shall be optimized to produce the highest possible fan static efficiency.
   2. Mount the fan and motor assembly on a common adjustable base to allow adjustable and consistent belt tension. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the AHU floor and mount directly to the AHU frame.
   3. Provide flexible duct connection on the inlet of each plenum fan.
   4. Provide thrust restraints, OSHA approved belt guards, inlet screens, and OSHA approved fan cages. Belt guards shall be sized to allow fan and belt sheaves to be increased by two sizes.
   5. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be provided on the motor with the fan wheel mounted directly on the motor shaft.
   6. Fans shall be AMCA 210/300 rated for Air and Sound Performance.
   7. Motors: Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment" for requirements.

E. Coil Section:
   1. Fabricate coil sections to allow for unimpeded access for service and maintenance of coil(s).
   2. Coil header and return bends shall be completely enclosed by the air-handling unit casing. Piping connections, including air vents and coil drains, shall extend to outside the casing through rubber grommet holes and escutcheons sealed with industrial silicone caulk.
   3. Provide sheet metal blank-offs around coil(s) to prevent air from bypassing around them.
   4. Water coils shall have 5/8" x 0.020 inch tube walls, and 0.0075 inch thick aluminum fins. Provide coils with ½" x .020 inch tubes if the flow is less than 25 GPM to increase the fluid tube velocity. Manufacture shall circuit the coils to maintain a fluid tube velocity rate between 3-5 fps. Cooling coils shall not be higher than 48" header height. Coil U-bends shall be full tube thickness.
   5. Direct Expansion coils shall be designed and fabricated in compliance with ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration." Coils shall have the following features:
      a. Suction Headers and Distributor Tubes: Seamless copper. Coils with more than 12 circuits shall have two distributors. Split circuit coils shall have two distributors
      b. Venturi-type refrigerant distributor, designed for low pressure drop, arranged for down feed with solder connections, and having a maximum of 12 circuits for each distributor.
   6. Provide stainless steel coil casings for cooling coils and galvanized steel coil casings for heating coils to mitigate corrosion.
   7. Individual Coil Racking: All cooling coil racking shall be constructed of #304 stainless steel, and heating coil racking shall be galvanized steel. All coils shall be individually racked so that if any one coil needs to be replaced the adjacent coil and piping will not be disturbed and be available for service. Provide access panels to remove the individual coils from the side of the unit.
   8. Coil Removal: Coils and coil sections shall be mounted on coil racks designed to allow the coils to be removed individually by sliding out through removable access panels in the casing wall. Racks for the cooling coils shall be stainless steel, and heating coil racks shall be galvanized. Racks that slide the coils out through access doors are not acceptable.

F. Single-Wall Drain Pans: IAQ type double sloped drain pan formed of galvanized sheet steel. Pans shall be insulated double wall construction fabricated in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at the maximum cataloged face velocity across the cooling coil.
   1. Drain connections: The pan shall drain to the side of the unit nearest to the floor drain. Verify the location on the plans. Construct and install pan to provide adequate pitch to drain.
   2. Pan top surface coating: Elastomeric compound.
   3. Units with stacked coils shall have an intermediate drain pan or a drain trough to collect condensate from top oil.

G. Dampers:
   1. General: Leakage rate when tested in accordance with AMCA Standard 500 - Test Method for Louvers, Dampers and Shutters, shall not exceed 2 percent of air quantity calculated at 2,000 fpm face velocity through damper and 4.0 inches wg pressure differential.
      a. Damper operators are specified in Division 23 Section 23 09 00 "Building Automation System".

H. Filters Section:
   1. General: Filters shall comply with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."
   2. Extended Surface Filters: Provide filter section and media as indicated.
      a. Pre-Filters: Provide disposable type air filters 2 inches thick, consisting of viscous coated fibers with filtering media encased in fiberboard cell sides having perforated metal grids on each face to provide media support. Airflow resistance with clean media shall not exceed 0.20 inch wg at face velocity of 300 fpm. Filters shall have a MERV 8 efficiency rating in accordance with ASHRAE Test Standard 52 - Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

b. Extended Surface Self-Supporting Filters: Provide factory-fabricated, dry, extended surface self-supporting filters with holding frames; where indicated, in sizes indicated. Equip with UL Class 1 fibrous media material constructed so that individual pleats are maintained in tapered form by flexible internal supports under rated air flow conditions. Construct holding frames of 18-ga galvanized steel and provide suitable fasteners and gasketing to hold filter units and to prevent unfiltered air passing between media frames and holding devices. Design holding frames which are suitable for bolting together into built-up filter banks. Provide filters with rate face velocity of 500 fpm, initial resistance of 0.25" wag. Filters shall have a MERV 13 efficiency rating in accordance with ASHRAE Test Standard 52 – Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

I. Controls: Controls will be field installed.
   1. Variable frequency drives for fans are provided by the Building Automation System Contractor and installed by the Electrical Contractor

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of central-station air-handling units.

B. Examine casing insulation materials and filler media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine rough-in for hydronic, condensate drainage piping and electrical to verify actual locations of connections prior to installation.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Install central-station air-handling units level and plumb, in accordance with manufacturer's written instructions.
   1. Support floor-mounted units on concrete equipment bases. Secure units to anchor bolts installed in concrete equipment base.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used or during construction with new clean filters.

3.03 EQUIPMENT BASES

A. Construct concrete equipment pads as follows:
   1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4 inches larger in both directions than the overall dimensions of the supported unit.
   2. Place anchor bolts and sleeves to facilitate securing units.
   3. Allow concrete to cure before installation of units.
   4. Clean exposed steel form and apply 2 coats of rust-preventative metal primer.

3.04 CONNECTIONS

A. Piping installation requirements are specified in Section 23 21 13 "Hydronic Piping". The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:
   1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
   2. Connection piping to air-handling units with flexible connectors.
   3. Connect condensate drain pans using 1-1/4-inch, Type M copper tubing. Extend to the nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

B. Duct installations and connections are specified in Section 23 31 13 "Ductwork" and 23 33 00 "Air Duct Accessories". Make final duct connections with flexible connections.

C. Connection requirements for units shipped in sections.
   1. The mechanical contractor is responsible for all field wiring required as a result of units shipped in sections. Complete wiring in accordance with manufacturer's instructions and guidelines. Comply with all NEC requirements. Field wiring shall be verified and approved by the equipment manufacturer and shall not void the warranty.

D. Electrical Connections: The following requirements apply:
   1. Electrical power wiring is specified in Division 26.
   2. Temperature control wiring and interlock wiring is specified in Section 23 09 00 Building Automation System
   3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:
   1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
   2. Prepare a written report on findings and recommended corrective actions.

3.06 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.

B. Adjust damper linkages for proper damper operation.

C. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.

3.07 SYSTEM START-UP

A. Provide the services of a factory authorized service representative to provide start-up services.

B. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
   1. Remove shipping, blocking, and bracing.
   2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
   3. Perform cleaning and adjusting specified in this Section.
   4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
   5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
   6. Set outside-air and return-air mixing dampers to minimum outside-air setting.
   7. Comb coil fins for parallel orientation.
   8. Install clean filters.
   9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
   10. Disable automatic temperature control operators.

C. Starting procedures for central-station air-handling units:
   1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
      a. Replace fan and motor pulleys as required to achieve design conditions.
   2. Measure and record motor electrical values for voltage and amperage.

D. Shut unit down and reconnect automatic temperature control operators.

E. Refer to specification section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

3.08 TEMPORARY OPERATION

A. Manually operate air handling systems to provide suitable environment for installation of interior finishes. Perform commissioning operations prior to starting units. Follow commissioning starting procedures and the following manual operation sequence:

1. Open outdoor air dampers, close return air dampers, open all air terminals to full open. Verify filters installed, heating coil operating (outdoor air temperatures below 40° F), condensate drain functioning, and electrical protection devices installed. Start fan, monitor indoor and outdoor conditions, and manually operate heating and cooling systems to control space conditions; shut down systems completely and close outdoor air dampers at end of each workday.

3.09 PROJECT CLOSEOUT

A. Replace fan drives and sheaves as directed by the Engineer as required for systems to perform to the intended design conditions. The Contractor's bid shall include labor and materials required to replace the quantity of drives and sheaves specified in Part 1.0 "Extra Materials."

B. Replace fan motors as directed by the Engineer as required for systems to perform to the intended design conditions. The Contractor's bid shall include all material and labor required to replace the quantity at motors, specified in Part 1.0 "Extra Materials."

3.10 DEMONSTRATION AND TRAINING

A. Provide demonstration and training for Owner's representative in accordance with Division 1 specification sections.

END OF SECTION 23 73 13

SECTION 23 81 26
SPLIT SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.02 SUBMITTALS

A. Provide product data for each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics. Include plans, elevations, sections, details, and attachments to other work. Include detailed equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include power, signal, and control wiring diagram.

1.03 CLOSEOUT DOCUMENTATION

A. Maintenance Manuals: Submit maintenance manuals in accordance with Division 1 Section "Operating, Maintenance, and Warranty Data".

B. Warranty: Submit special warranty specified in this Section.

C. Submit field quality control reports.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Units shall be designed to operate with HCFC-free refrigerants.

1.05 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate layout and installation of computer-room air conditioners and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partitions assemblies.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mitsubishi Electronics America, Inc.; HVAC Division.
2. Sanyo Fisher (U.S.A.) Corp.
3. Samsung.

2.02 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: Direct drive, centrifugal fan.

D. Filters: Permanent, cleanable.

2.03 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Scroll.
2. Manual-reset high-pressure switch and automatic-reset low-pressure switch.
3. Refrigerant Charge: R-410A.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Fan: Aluminum-propeller type, directly connected to motor.

E. Mounting Base: Polyethylene.

F. Low Ambient Kit: Permits operation down to the ambient air temperature indicated.

1. -20 Deg F

2.04 MOTORS

A. Comply with requirements in Division 23 Section “Common Work Requirements for HVAC Equipment”, including, but not limited to, efficiency and power factor correction requirements.

1. Motor Sizes: Minimum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.05 ACCESSORIES

A. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection, including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

E. Provide integral condensate pump.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base. Install ground-mounting, compressor-condenser components on polyethylene mounting base.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

E. Install the associated condensate pump where indicated on the drawings to be provided. Install in accordance with all manufacturer's instructions and guidelines.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 or 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Provide 1" type L condensate drain routed to the nearest floor drain.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Install power and control wiring to the associated condensate pump in accordance with manufacturer's instructions as work of this section. All wiring shall conform to Division 26 requirements.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate and maintain split system air-conditioners. Refer to Division 01 Section "Demonstration and Training."
   1. Required Time: 2 hours.

END OF SECTION 23 81 26

SECTION 23 81 29
VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes complete VRF HVAC system(s) which may include, but not limited to, the following components:
   1. Indoor, concealed, ceiling-mounted units for ducting.
   2. Indoor, recessed, ceiling-mounted units with 33x33” grilles.
   3. Indoor, recessed, ceiling-mounted units with 24x24” grilles.
   4. Indoor, heat recovery control units (HRCUs).
   5. Outdoor, air-source heat-pump units.
   6. Outdoor, air-source heat recovery units.
   7. VRF system controls.
   8. VRF system refrigerant and oil.
   9. VRF system condensate drain piping.
   10. VRF system hydronic piping and water quality.
   11. VRF system refrigerant piping.
   12. VRF system control cable.

1.02 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.
   1. Each employee shall be certified to have successfully completed manufacturer training for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
   2. Installer certificate shall be valid and current for duration of Project.
   3. Retain copies of Installer certificates on-site and make available on request.
   4. Each person assigned to Project shall have demonstrated past experience.
      a. Demonstrated past experience with VRF products being installed for period within three consecutive years before time of bid.
      b. Demonstrated past experience on projects of similar VRF system complexity, scope, and value.

B. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
   1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

B. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

C. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

1.04 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Faulty operation.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:
    a. For Compressor, 10 year(s) from date of Substantial Completion.
    b. For Parts, One year(s) from date of Substantial Completion.

B. Installer's Labor Warranty: Installer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.
1. Warranty Period 1 year(s) from date of substantial completion.

PART 2 PRODUCTS

2.01 VRF HVAC SYSTEMS

A. Manufacturers: Basis of design is CITY MULTI. Subject to compliance with requirements, provide products by one of the following brands only:
1. Mitsubishi Electric & Electronics USA, Inc.
2. Trane, Inc.
3. Toshiba Carrier Co., Ltd.
4. Daikin Applied
5. Johnson Controls, Inc.

2.02 SYSTEM DESCRIPTION

A. VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
1. System(s) operation being heat pump or heat recovery as indicated on Drawings.
2. Each system with one refrigerant circuit serving all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230-2023.

D. UL Compliance: Comply with UL 60335-2-40.

2.03 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

A. Description: Factory-assembled and tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:
1. Material: Galvanized steel.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Coil Assembly:
1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Capacity Control: DX coil by electronic modulating type valve with linear or proportional characteristics. Hydronic coil by modulating control valve.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Factory Charge: Dehydrated air or nitrogen.
8. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
   1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
   2. Condensate Removal: Unit-mounted lifting mechanism, capable of lifting drain water to an elevation above top of cabinet (sizes 54 and smaller only).
   3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:
   1. Fan(s):
      a. Direct-drive arrangement.
      b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
      c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
      d. Wheels statically and dynamically balanced.
   2. Motor: PSC, Brushless DC or electronically commutated with permanently lubricated bearings.
   3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
   4. Speed Settings and Control: Multiple or variable speed with speed setting adjustable via central or wall controllers when present.
   5. External Static Settings: Vary based on Low, Medium, or High Static models. Models as shown on Drawings
      a. Low Static settings include 0.02, 0.06, 0.14, or 0.20” WG.
      b. Medium Static settings include 0.14, 0.20, 0.28, 0.40, or 0.60” WG.
      c. High Static settings include 0.40 or 1.00” WG for 208V and 0.60 or 1.00” WG for 230V.
   6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:
   1. Access: Bottom, side, or rear to accommodate field installation and replacement without need for tools.
   2. Media: Poly Propylene Honeycomb Fabric (Washable) with Low and Medium Static models. No filter provided with High Static models.

G. Field-Installed Unit Accessories:
   1. Side-access filter box with one set MERV 13 Filter.

H. Unit Controls:
   1. Factory-Installed Sensors:
      a. Unit inlet air temperature.
      b. Coil entering refrigerant temperature.
      c. Coil leaving refrigerant temperature.
   2. Interlocked control sequence: Four digital inputs and three digital outputs for use in defined or customizable interlock sequences; relay adapter kits may be required. Required interlock sequence(s) include-
      a. backup heat control.
      b. on/off and fault status.
      c. mode and fan status.
   3. Features and Functions:
      a. Self-diagnostics.
      b. Time delay.
      c. Auto-restart.
      d. External static pressure control.
      e. Auto operation mode.
      f. Manual operation mode.
      g. Filter service notification.
      h. Drain assembly high water level safety shutdown and notification.
      i. Run test switch.

I. Unit Electrical:
   1. Field Connection: Single point connection to power unit and integral controls.
   2. Disconnecting Means: Field-installed circuit breaker or switch.

2.04 INDOOR, RECESSED, CEILING-MOUNTED UNITS WITH 33X33" GRILLES

A. Description: Factory-assembled and tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:
   1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
   2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
   3. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Coil Assembly:
   1. Coil Casing: Aluminum, galvanized, or stainless steel.
   2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
   3. Coil Tubes: Copper, of diameter and thickness required by performance.
   4. Capacity Control: DX coil by electronic modulating type valve with linear or proportional characteristics. Hydronic coil by modulating control valve.
   5. Internal Tubing: Copper tubing with brazed joints.
   6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   7. Factory Charge: Dehydrated air or nitrogen.
   8. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
   1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
   2. Condensate Removal: Unit-mounted integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
   3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:
   1. Fan(s):
      a. Direct-drive arrangement.
      b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
      c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
      d. Wheels statically and dynamically balanced.
   2. Motor: Brushless DC or electronically commutated with permanently lubricated bearings.
   3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
   4. Speed Settings and Control: Multiple or variable speed with speed setting adjustable via central or wall controllers when present.
      a. Airflow volume shall vary based on three unit height settings.
   5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:
   1. Access: Bottom, to accommodate filter replacement without the need for tools.
   2. Media: Washable screen.

G. Return/Discharge-Air Grille Assembly: Attached to bottom of unit cabinet.
   1. Discharge Pattern: Include accessory air outlet shutter plates as required for two, three, or four-way throw as indicated on Drawings.
      a. Discharge Pattern Adjustment: Field-adjustable settings for up and down range of motion.
      b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns using wall-mounted controller.

2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
3. Alternate Branch Supply Duct Connection: Sheet metal knockout for optional connection to one supply branch duct as shown on Drawings. Utilize accessory air outlet shutter plate with branch ducting.

H. Integral Occupant and Location Detection: Unit includes occupant and location detection for automatic air distribution and energy saving setback control in the following manner.
1. Air Distribution
a. Default distribution operation: Integral occupant and location detection will not be utilized to control air distribution. During COOL mode, vanes move to horizontal airflow direction. During HEAT mode, vanes move to down airflow direction.
2. Energy Saving
a. No occupancy-based energy save: If there are no persons in the room for 60 minutes or more, energy saving operation (setback) equal to 4°F is performed.

I. Outdoor Air Ventilation Connection: Sheet metal knockout for connection to outdoor air ventilation duct per Drawings.

J. Field-Installed Unit Accessories:
1. None.

K. Unit Controls:
1. Factory-Installed Sensors:
a. Unit inlet air temperature.
b. Coil entering refrigerant temperature.
c. Coil leaving refrigerant temperature.
d. Room occupancy/location
2. Interlock control sequence: Four digital inputs and three digital outputs for use in defined or customizable interlock sequences; relay adapter kits may be required. Required interlock sequence(s) include-
a. backup heat control.
b. on/off and fault status.
c. mode and fan status.
3. Features and Functions:
a. Integral occupancy and location sensor.
b. Time delay.
c. Auto-restart.
d. Auto operation mode.
e. Manual operation mode.
f. Filter service notification.
g. Drain assembly high water level safety shutdown and notification.
h. Run test switch.

L. Unit Electrical:
1. Field Connection: Single point connection to power entire unit and integral controls.
2. Disconnecting Means: Field-installed circuit breaker or switch, complying with NFPA 70.

2.05 INDOOR, RECESSED, CEILING-MOUNTED UNITS WITH 24X24" GRILLES

A. Description: Factory-assembled and tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:
1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.

2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Coil Assembly:
1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Capacity Control: DX coil by electronic modulating type valve with linear or proportional characteristics. Hydronic coil by modulating control valve.
5. Internal Tubing: Copper tubing with brazed joints.
6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Factory Charge: Dehydrated air or nitrogen.
8. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:
1. Fan(s):
   a. Direct-drive arrangement.
   b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
   c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
   d. Wheels statically and dynamically balanced.
2. Motor: Brushless DC or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Multiple or variable speed with speed setting adjustable via central or wall controllers when present.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:
1. Access: Bottom, to accommodate filter replacement without the need for tools.
2. Media: Washable screen.

G. Return/Discharge-Air Grille Assembly: Attached to bottom of unit cabinet.
1. Discharge Pattern: Four-way throw.
   a. Discharge Pattern Adjustment: Field-adjustable settings for up and down range of motion for individual vanes. Provide Deluxe controller to enable configuration.
2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

H. Integral Occupant and Location Detection: Unit includes occupant and location detection for automatic air distribution and energy saving setback control in the following manner-
1. Air Distribution
   a. Default distribution operation: Integral occupant and location detection will not be utilized to control air distribution. During COOL mode, vanes move to horizontal airflow direction. During HEAT mode, vanes move to down airflow direction.
2. Energy Saving
   a. “No occupancy energy save”: If there are no persons in the room for 60 minutes or more, energy saving operation (setback) equal to 4°F is performed.

I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

J. Field-Installed Unit Accessories:
    1. None.
K. Unit Controls:
    1. Factory-Installed Sensors:
        a. Unit inlet air temperature.
        b. Coil entering refrigerant temperature.
        c. Coil leaving refrigerant temperature.
    2. Interlock control sequence: Four digital inputs and three digital outputs for use in defined or customizable interlock sequences; relay adapter kits may be required. Required interlock sequence(s) include-
        a. backup heat control.
        b. on/off and fault status.
        c. mode and fan status.
    3. Features and Functions:
        a. Integral occupancy and location sensor.
        b. Time delay.
        c. Auto-restart.
        d. Auto operation mode.
        e. Manual operation mode.
        f. Filter service notification.
        g. Drain assembly high water level safety shutdown and notification.
        h. Run test switch.
L. Unit Electrical:
    1. Field Connection: Single point connection to power entire unit and integral controls.
    2. Disconnecting Means: Field-installed circuit breaker or switch, complying with NFPA 70.

2.06 INDOOR, HEAT RECOVERY CONTROL UNITS (HRCUS)

A. Description: Factory-assembled and tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
    1. Specially designed for use in systems with simultaneous heating and cooling.
    2. Systems shall include one or multiple units designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit and multiple indoor units.
    3. Units shall respond to calls for HEAT or COOL operation from indoor units by enabling refrigerant or water flow as equipment shown on Drawings require.
        a. If flow direction from HRCU alternates, flow in COOL direction to units in HEAT mode during outdoor unit defrost sequence is not allowed.
B. Cabinet:
    1. Galvanized-steel construction.
    2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
    3. Internal Access:
        a. Removable panels or hinged doors of adequate size.
        b. Access to all internal components for inspection, cleaning, service, or replacement.
C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
D. Assemblies and Specialties:
    1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
    2. Each branch circuit shall have refrigerant and/or water control valve(s) to control flow.
    3. Each branch port connection shall be fitted with an isolation valve to simplify service to any individual branch.

E. Unit Controls:
   1. Factory-Installed Sensors:
      a. Liquid inlet temperature.
      b. Bypass exit area temperature.
      c. Bypass outlet temperature.
      d. Bypass inlet temperature.
      e. High pressure sensor.
      f. Medium pressure sensor.
   2. Features and Functions: Self-diagnostics, fuse protection.
F. Unit Electrical:
   1. Field Connection: Single point connection to power entire unit and integral controls.
   2. Disconnecting Means: Field-installed circuit breaker or switch, complying with NFPA 70.

2.07 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

A. Description: Factory-assembled and tested complete unit designed for use in systems with simultaneous heating and cooling.
   1. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit, heat recovery control unit(s), and multiple indoor units.
B. Cabinet:
   1. Galvanized steel and coated with a corrosion-resistant finish.
      a. Coating with documented salt spray test performance of 1000 hours according to ASTM B117 surface scratch test (SST) procedure.
   2. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
C. Compressor and Motor Assembly:
   1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive. Non-inverter compressors—where LRA applies—are not allowed.
   2. Cold-Climate Compressor: Hot gas injection to allow increased compression ratio for extended periods without damage or excessive wear.
   3. Protection: Integral protection against the following-
      a. Refrigerant overcharge and undercharge
      b. High and low refrigerant pressure.
      c. High refrigerant and oil temperature.
      d. Liquid flood back.
      e. Thermal and overload.
      f. Voltage fluctuations.
      g. Phase failure and phase reversal.
      h. Short cycling.
   4. Speed Control: Configurable to maintain refrigerant evaporating and condensing temperatures while varying refrigerant flow to satisfy cooling and heating loads.
      a. Cooling mode fixed 32°F evaporator temperature.
      b. Cooling mode fixed 43°F evaporator temperature.
      c. Cooling mode variable 32-48°F evaporator temperature.
      d. Heating mode high COP operation.
      e. Heating mode high heating output operation.
   5. Vibration Control: Integral isolation to dampen vibration transmission.
   6. Oil Management: Timed sequence enabled during extended periods of reduced refrigerant flow to ensure proper lubrication over entire operating range. Sequences which rely on sensing oil level risk sensor failure or sensor placement not accounting for line length and are not allowed.

7. Crankcase heaters with integral control to maintain safe operating temperature.
8. Fusible plug.

D. Heat-Exchanger Assembly: Documented salt spray test performance of 1000 hours according to ASTM B117 surface test (SST) procedure.
   1. Plate Fin Coils:
      a. Casing: Aluminum, galvanized, or stainless steel.
      b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
      c. Tubes: Copper, of diameter and thickness required by performance.
   2. Zinc-Coated Aluminum Microchannel Coils:
      a. Series of flat tubes containing a series of multiple, parallel flow microchannels layered between refrigerant header manifolds.
      b. Construct fins, tubes, and header manifolds of aluminum alloy.
      c. Provide coil panel heaters for heating operation below 0°F per Drawings.

E. Heat-Exchanger Defrost Strategy:
   1. Alternate methods based on ambient temperatures.
      a. Hot-gas method to maximize efficiency during mild ambient temperatures. Method prolongs defrost sequence.
         1) Segmented coil (single-module systems) or alternating modules (twinned systems) to deliver simultaneous defrost and HEAT delivery indoors.
      b. Reverse-cycle method to maximize comfort during extreme ambient temperatures. Method shortens defrost sequence.
         1) Leverage below 33.8°F for single-module systems and below 23°F for twinned systems to deliver shorter defrost cycles.
   2. Preheat Defrost Operation: Signal to indoor units operating in HEAT to increase space temperature before the start of defrost sequence.

F. Heat-Exchanger Fan and Motor Assembly:
   1. Fan(s): Propeller type.
      a. Direct-drive arrangement.
      b. Fabricated from non-ferrous components.
      c. Statically and dynamically balanced.
   2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for heat exchanger coil.
   3. Motor(s): Brushless DC or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
   4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

G. Field-Installed Unit Accessories:
   1. Low Ambient Cooling Kit: Provide heat-exchanger coil wind deflectors and fan hood assembly for low ambient cooling operation to -10°F as indicated in Drawings.
   2. Snow/Hail Protection Kit: Provide heat exchanger coil guards and fan hoods to protect against hail damage.
   3. Refrigerant Filter/Cleaning System: Replaceable filter core in bypass arrangement from main suction flow to enhance installation quality assurance.
   4. Adjustable 13-26” height, Open-Design Equipment Support Stand.

H. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   3. Factory-Installed Sensors:
      a. Refrigerant suction temperature.
      b. Refrigerant discharge temperature.

c. Outdoor air temperature.
d. Refrigerant high pressure.
e. Refrigerant low pressure.

4. Features and Functions: Self-diagnostics, time delay, auto-restart.
5. Interlock control sequence: Customizable operation based on external input or contact closure. Required interlock sequence(s) include-
   a. Multi-stage demand limit.
   b. Low noise (nighttime) limit.
   c. Lock COOL or HEAT mode.
   d. Compressor on/off and fault status.

I. Unit Electrical:
1. Field Connection: Single point connection to power each unit module and integral controls.
2. Disconnecting Means: Field-installed circuit breaker or switch, complying with NFPA 70.

2.08 VRF SYSTEM CONTROLS

A. General Requirements:
1. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a manufacturer-selected control network.
2. Network Communication Protocol: Manufacturer proprietary control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following-
   a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.
   b. Integration shall include control, monitoring
4. Operator Interface:
   a. Operators shall interface with system and unit controls through the following:
      1) Operator interfaces integral to controllers
      2) Manufacturer-provided central controller.
      3) Integration with Building Automation System.
   b. Users shall be capable of interface with controllers for indoor units' control to extent privileges are enabled. Control features available to users shall include the following:
      1) On/off control.
      2) Temperature set-point adjustment.
      3) Fan speed control.

B. VRF HVAC System Operator Interface via PC:
1. Central controller(s) connected local-area-network shall be accessible through standard web browser software requiring no manufacturer-specific software be installed on owner-furnished PC.
2. Browser interface shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
8. Supports Multiple Languages: English, French, or Spanish.

9. Supports Imperial and Metric Temperature Units
10. Displays service notifications and error codes.
11. Monitors and displays cumulative operating time of indoor units.
12. Able to disable and enable operation of individual controllers for indoor units.
13. Information displayed on individual controllers shall also be available for display.

C. Central Controllers:
1. Centralized control for all indoor and outdoor units from a single central controller location.
   a. Include multiple interconnected controllers as required.
   b. Include backlit, high-resolution color display touch panel.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
   a. Sets schedule for daily, weekly, and annual events.
   b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Able to disable and enable operation of individual controllers for indoor units.
8. Information displayed on individual controllers shall also be available for display through central controller.
9. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
10. Start/stop control capability for third-party equipment as required.
11. License for Integration with Building Automation System: BACnet over IP communication of indoor unit monitor and control points.

D. Wired Controllers and Sensors for Indoor Units
1. Residential / Multi-Family Style Controllers for Indoor Units:
   a. Wall-mounted controller with integral room temperature and humidity sensors and adapter providing connection to indoor unit.
   b. Color LCD with click-wheel operation and Proximity Sensor to wake controller screen when approached.
   c. Automatic switching between Cool and Dry modes to meet target humidity level (user-selectable between 35-75%).
   d. Temperature Units: Fahrenheit and Celsius.
   e. On/Off: Turns indoor unit on or off.
   f. Hold: Hold operation settings until hold is released.
   g. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
   h. Temperature Display and Set-Point: Separate set points for Cooling, Heating. Adjustable in 1-degree Fahrenheit increments between.
   i. Fan Speed Setting: Select between available options furnished with unit.
   j. Airflow Direction Setting: If applicable to indoor unit style, select between available options furnished with the unit.
   k. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.

l. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
m. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
n. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost.
o. Low-voltage power required for controller shall be powered through polarity-specific connections to indoor unit.
p. Limits central control (when present) to monitor-only functionality.

2.09 VRF SYSTEM REFRIGERANT AND OIL

A. Refrigerant:
1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.
3. R-410a.

B. Oil:
1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.10 VRF SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.
B. Copper Tubing:
1. Drawn-Temper Tubing: According to ASTM B88, Type L
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.

C. Reducers: Where applied to piping connected to unit-mounted integral lifting mechanism, only eccentric reducers oriented horizontally are allowed.

2.11 VRF SYSTEM HYDRONIC PIPING AND WATER QUALITY

A. Hydronic Piping:
1. Drawn-Temper Tubing: According to ASTM B88, Type L
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.

B. Assemblies and Specialties:
1. Isolation ball valves with compression fittings.
2. Automatic air vents with hydroscopic cap.
3. Drain valves with brass NPT T-fitting.
4. Fittings for piping or tubing connection to HRCU.
5. System feeder with digital pressure control sized per VRF manufacturer.
6. Expansion tank sized per VRF manufacturer.
7. Expansion tank wall bracket with manual air vent and pressure gauge for accessory components.
a. FNPT Expansion Tank Connection with 3-way ETV ball valve.
b. 1⁄2” FNPT Fill/Feeder Inlet Connection with ball valve.
c. 1⁄2” FNPT System Connection with ball valve.

C. System Fluid Type: Propylene Glycol mixture per VRF manufacturer.
1. Refer to VRF manufacturer Installation Guide for water quality standard.

2.12 VRF SYSTEM REFRIGERANT PIPING

A. Refrigerant Piping:
1. Copper Tube: ASTM B280, Type ACR.
2. Wrought-Copper Fittings: ASME B16.22.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

B. Assemblies and Specialties:
   1. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

2.13 VRF SYSTEM CONTROL CABLE

A. General Requirements: Refer to and verify all wire and cabling requirements with the manufacturer's current installation and operation manuals to ensure compliance with the latest standards and specifications. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.
B. Low-Voltage Control Network Cabling:
   1. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
      a. Shielded wire (2-core) 16 AWG—CVVS, CPEVS or MVVS.
      b. PVC insulation and jacket.
      c. Foil shielded.
      d. Flame Resistance: Comply with NFPA 262.
      e. Maximum cable distance (distance to farthest components) is 1,640 feet (49987.2 cm).
      f. Maximum cable distance from OU to connected IU is 656 feet (19994.88 cm).
      g. Maximum total cable length (sum of all network cabling) is 6,560 feet (199948.8 cm).
C. Low-Voltage Wall-Mounted Controller Cabling to Indoor Units:
   1. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
      a. 22 AWG, 2-conductor unshielded 7-stranded bare copper wire.
         1) Residential / multi-family style controllers require 4-conductor.
         2) Touch controllers with integral occupancy and light sensing controllers require low-voltage control network cabling to the network.
      b. PVC insulation and jacket.
      c. Flame Resistance: Comply with NFPA 262.
      d. Maximum cable distance (distance from controller to indoor unit) varies by controller style. Refer to manufacturer Submittal or Installation Guides.
D. Transmission power booster provided if additional signal power is required based on connected devices. Coordinate with VRF manufacturer and install near middle of communication bus when required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.
D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.
E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.
F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:
   1. Maintain manufacturer's recommended clearances for service and maintenance.
   2. Maintain clearances required by governing code.
B. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.03 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.
B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch (9.52 mm).
C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.
E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch (6.35 mm).

3.04 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.
B. Install outdoor units on support structures indicated on Drawings.
C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
    1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
    2. Grouting: Place grout under equipment supports and make bearing surface smooth.

3.05 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.
B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping and tubing to permit valve servicing.
F. Install piping and tubing at indicated slopes.
G. Install piping and tubing free of sags.
H. Install fittings for changes in direction and branch connections.
I. Install piping and tubing to allow application of insulation.
J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.
K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.06 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:
    1. Install a union in piping at each threaded unit connection.
    2. Install an adjustable stainless steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
    3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
        a. Details indicated on Drawings.
        b. Manufacturer's requirements.

c. Governing codes.
d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:
1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:
1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.07 INSTALLATION OF HYDRONIC PIPING

A. Comply with requirements for hydronic pipe and tubing specified in Section 232113 "Hydronic Piping."
B. Comply with requirements for valves specified in Section 230523 "General Duty Valves for HVAC Piping."
C. Connections to HRCU shall be as shown on Drawings, with each indoor unit connected to specific port or HRCU circuit.
D. Install hydronic piping as short and direct as possible, with a minimum number of joints and fittings.
E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
F. Where installing piping and tubing adjacent to equipment, allow space for service and maintenance.
G. Joint Construction:
1. Brazed Joints
a. Ream ends of tubes and remove burrs.
b. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
c. Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
d. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.
e. The piping being brazed shall be purged of air to remove the oxygen and filled with one of the following inert gases: oxygen-free nitrogen, helium or argon. The piping system shall be purged with an inert gas for a minimum time corresponding to five volume changes through the piping system prior to brazing. The pre-purge rate shall be at a minimum velocity of 100 feet (3048 cm) per minute (0.56 yard (0.508 meter)/s). The inert gas shall be directly connected to the tube system being brazed to prevent the entrainment of ambient air. After the pre-purge, the inert gas supply shall be maintained through the piping during the brazing operation at a minimum pressure of 1.0 psi (6.89 kPa) and a maximum pressure of 3.0 psi (20.68 kPa). The joint shall be brazed with a filler metal conforming to AWS A5.8
2. Mechanically Pressed Joints
a. The installing contractor shall be fully trained and qualified by the manufacturer of the mechanically pressed joints to install the selected piping connections.
b. Mechanical joints shall be installed in accordance with the manufacturer’s instructions.
3. Flared Joints
a. Flared fittings shall be installed in accordance with the manufacturer’s instructions. The flared fitting shall be used with the tube material specified by the fitting manufacturer. The flared tube end shall be made by a tool designed for that operation.
4. Soldered Joints
a. Use of soldered joints is prohibited within VRF systems.

3.08 INSTALLATION OF REFRIGERANT PIPING

A. Select system components with minimum 650 psig (4481.59 kPa) pressure rating.

B. Install piping as short and direct as possible, with a minimum number of joints and fittings.

C. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

D. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

E. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:
   1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Traps to entrain oil in vertical runs are not allowed.
   4. Inverted traps for twinned systems may be required by manufacturer.
   5. Liquid lines may be installed level.

F. When brazing, remove or protect components that could be damaged by heat. Braze pipes with a dry nitrogen purge to avoid oxidation.

G. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

H. Joint Construction:
   1. Brazed Joints
      a. Ream ends of tubes and remove burrs.
      b. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
      c. Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
      d. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.
      e. The piping being brazed shall be purged of air to remove the oxygen and filled with one of the following inert gases: oxygen-free nitrogen, helium or argon. The piping system shall be purged with an inert gas for a minimum time corresponding to five volume changes through the piping system prior to brazing. The pre-purge rate shall be at a minimum velocity of 100 feet (3048 cm) per minute (0.56 yard (0.508 meter)/s). The inert gas shall be directly connected to the tube system being brazed to prevent the entrainment of ambient air. After the pre-purge, the inert gas supply shall be maintained through the piping during the brazing operation at a minimum pressure of 1.0 psi (6.89 kPa) and a maximum pressure of 3.0 psi (20.68 kPa). The joint shall be brazed with a filler metal conforming to AWS A5.8
   2. Mechanically Pressed Joints
      a. The installing contractor shall be fully trained and qualified by the manufacturer of the mechanically pressed joints to install the selected piping connections.
      b. Mechanical joints shall be installed in accordance with the manufacturer’s instructions.
   3. Flared Joints
      a. Flared fittings shall be installed in accordance with the manufacturer’s instructions. The flared fitting shall be used with the tube material specified by the fitting manufacturer. The flared tube end shall be made by a tool designed for that operation.
   4. Soldered Joints
      a. Use of soldered joints is prohibited within VRF systems.

3.09 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints, for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

E. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (304.8 mm) o.c. and at end joints.

3.10 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.

B. Comply with requirements for ducts specified in Section 233113 "Ductwork”.

C. Comply with requirements for air duct accessories specified in Section 233300 "Air Duct Accessories."

3.11 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.12 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
   1. Field service shall be performed by a manufacturer-trained and authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
   2. Manufacturer-trained and authorized service representative shall provide on-site visits during construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.
      a. First Visit: Kick-off meeting.
      b. Second Visit: At approximately 25 percent completion of system(s).
      c. Third Visit: At approximately 50 percent completion of system(s).
      d. Fourth Visit: At approximately 75 percent completion of system(s).
      e. Fifth Visit: Final inspection before system startup.

3. Kick-off Meeting:
    a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
    b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
    c. Meeting shall cover the following as a minimum requirement:
        1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
        2) Manufacturer's installation requirements specific to systems being installed.
        3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
        4) Required field activities related installation of VRF HVAC system.
        5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.
4. Site Visits: Activities for each site visit shall include the following:
    a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
    b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
    c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
    d. Advise and if necessary, assist Installer with updating related refrigerant calculations and system documentation.
5. Final Inspection before Startup:
    a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according to manufacturer's requirements and ready for final inspection.
    b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
    c. A factory-trained and authorized service representative shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
    d. Inspection reports for indoor units shall include, but not be limited to, the following:
        1) Unit designation on Drawings.
        2) Manufacturer model number.
        3) Serial number.
        4) Network address, if applicable.
        5) Each equipment setting.
        6) Mounting, supports, and restraints properly installed.
        7) Proper service clearance provided.
        8) Wiring and power connections correct.
        9) Line-voltage reading(s) within acceptable range.
        10) Wiring and controls connections correct.
        11) Low voltage reading(s) within an acceptable range.
        12) Controller type and model controlling unit.
        13) Controller location.
        14) Temperature settings and readings within an acceptable range.
        15) Condensate removal acceptable.
        16) Fan settings and readings within an acceptable range.

17) Unit airflow direction within an acceptable range.
18) If applicable, fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Refrigerant or hydronic piping properly connected and insulated.
22) Condensate drain piping properly connected and insulated.
23) If applicable, ductwork properly connected.
24) If applicable, external interlocks properly connected.
25) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:
1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting, including compressor speed control.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) For water-source outdoor units, water piping properly connected and insulated.
17) For water-source outdoor units, proof of water flow checked for proper operation.
18) Remarks.

f. Installer shall provide manufacturer with the requested documentation including as-built piping lengths and technical support during inspection.

g. Installer shall correct observed deficiencies found by the inspection.

h. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.

i. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved, and systems are deemed ready for startup.

j. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: Not less than 24 hours after electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant and Hydronic Tubing Positive Pressure Testing:
   1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
   2. After completion of tubing installation, pressurize tubing systems to a test pressure:
      a. Refrigerant piping to a test pressure of not less than 600 psig (4136.86 kPa) using dry nitrogen.
      b. Hydronic piping to a test pressure of not less than 43 psig (296.47 kPa).
   3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
   4. Prepare test report to record the following information for each test:
      a. Name of person starting test, company name, phone number, and e-mail address.
      b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
      c. Detailed description of extent of tubing tested.
      d. Date and time at start of test.
      e. Test pressure at start of test.
      f. Outdoor temperature at start of test.
      g. Name of person ending test, company name, phone number, and e-mail address.
      h. Date and time at end of test.
      i. Test pressure at end of test.
      j. Outdoor temperature at end of test.
      k. Remarks:
   5. Submit test reports for Project record and to system manufacturer.

D. Refrigerant Tubing Evacuation Testing:
   1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
   2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
   3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour with no change.
   4. Prepare test report to record the following information for each test:
      a. Name of person starting test, company name, phone number, and e-mail address.
      b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
      c. Detailed description of extent of tubing tested.
      d. Date and time at start of test.
      e. Test pressure at start of test.
      f. Outdoor temperature at start of test.
      g. Name of person ending test, company name, phone number, and e-mail address.
      h. Date and time at end of test.
      i. Test pressure at end of test.
      j. Outdoor temperature at end of test.
      k. Remarks:
   5. Submit test reports for Project record and to system manufacturer.
   6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:
   1. System Installer shall consult system manufacturer to determine the correct system refrigerant charge based on as-built piping lengths.
   2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
   3. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

3.13 STARTUP SERVICE

A. Installer shall engage a factory-trained and authorized service representative of VRF HVAC system manufacturer to perform system(s) startup supervision.
   1. Complete startup service of each separate system.
   2. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:
   1. Check control communications of equipment and each operating component in system(s).
   2. Check each outdoor unit’s power supply is connected 12 to 24 hours before startup of system.
   3. Check each indoor unit's response to demand for cooling and heating.
   4. Check each indoor unit's response to changes in airflow settings.
   5. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.

C. Installer shall accompany factory-trained and authorized service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
   1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:
   1. After completion of startup service, manufacturer shall issue a report for each separate system.
   2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
   3. Manufacturer shall electronically record not less than one hour of continuous operation of each system and submit with report for historical reference.
      a. All available system operating parameters shall be included in the information submitted.

E. Witness:
   1. Invite Architect, Owner, and Commissioning Agent to witness startup service procedures.
   2. Provide written notice not less than 20 business days before start of startup service.

3.14 ADJUSTING

A. Adjust equipment and components to function smoothly and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches according to VRF HVAC system manufacturer's written instructions, and as indicated.

3.15 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of system Installer who are manufacturer's authorized service representative. Include two service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.16 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:
   1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.

C. Schedule:
   1. Schedule training with Owner at least 10 business days before first training session.
   2. Training shall occur before Owner occupancy.
   3. Training shall be held at mutually agreed date and time during normal business hours.

D. Location: Owner shall provide a suitable on-site location to host classroom training.
E. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.
F. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.
G. Training Materials: Provide training materials in electronic format to each attendee.
    1. Offer online instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
H. Acceptance: Obtain Owner written acceptance that training is complete, and requirements indicated have been satisfied.

END OF SECTION 23 81 29

SECTION 23 82 33
HEATING TERMINAL UNITS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Finned tube radiation.
   2. Unit heaters.
   3. Cabinet heaters.
   4. Water duct coils.

1.02 QUALITY ASSURANCE

A. Codes and Standards:
   1. I=B=R Compliance: Test and rate baseboard and finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.
   2. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".
   3. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
   4. ARI Compliance: Test and rate fan-coil units in accordance with ARI Standard 440 "Room Fan-Coil Air-Conditioners".
   5. UL Compliance: Construct and install fan-coil units in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units.
   6. ARI Compliance: Test and rate unit ventilators in accordance with ARI Standard 330 "Unit Ventilators".
   7. UL Compliance: Provide electrical components for terminal units, which have been listed and labeled by UL.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.
B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.
C. Wiring Diagrams submit manufacturer's electrical requirements for power supply wiring to terminal units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
D. Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals in accordance with requirements of Division 1.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.
D. Deliver terminal units to job site tagged with label indicating project name, model number, unit number, and details of installation (i.e. room number orientation, etc.).

PART 2 PRODUCTS

2.01 FINNED TUBE RADIATION

A. Manufacturers: Subject to compliance with requirements, manufacturers offering finned tube radiation which may be incorporated in the work include the following:
   1. Sterling Radiator, Div. of Reed National Corp.
   2. Trane (The) Co.

3. Vulcan Radiator Co.
4. Rittling.
5. Dunham Bush.
6. Sigma Corporation.

B. General: Provide finned tube radiation of lengths and in locations as indicated, and of capacities, style, and having accessories as scheduled.

C. Cabinets: Minimum 18-ga cold-rolled steel full backplate, minimum 16-ga front. Brace and reinforce front minimum of 4'-0" o.c. without visible fasteners.

D. Elements: Copper tube and aluminum fins, with tube mechanically expanded into fin collars to eliminate noise and ensure durability and performance at scheduled ratings.

E. Finish: Factory finished baked enamel, standard colors as selected by the Architect, on fronts and accessories.

F. Accessories:
1. End panels, inside and outside corners, and enclosure extensions.
2. Access panels in front of valves, balancing cocks, and traps.
3. Sill extensions.
4. Mullion channels.
5. Pilaster covers.

G. Pipe Hangers and Supports: Comply with the finned tube manufacturer's guidelines. Pipe supports shall typically be a type intended to accommodate thermal expansion by allowing free longitudinal movement and restricting lateral movement. Refer to the drawings and other specification sections to determine if additional thermal expansion devices are required (expansion compensators, pipe guides, and pipe anchors, etc.).

2.02 UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering unit heaters which may be incorporated in the work include the following:
1. Airtherm Mfg. Co.
2. Dunham-Bush, Inc.
3. McQuay, Inc.
4. Modine Mfg. Co.
5. Trane (The) Co.
6. Sterling Radiator Co.
7. Rittling
8. Sigma Corporation.

B. General: Provide unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.

C. Cabinet: Removable panels for maintenance access to controls.

D. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

E. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

F. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.

G. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

H. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

2.03 CABINET HEATERS

A. Manufacturer: Subject to compliance with requirements, provide cabinet heaters of one of the following:
1. Airtherm Mfg. Co.
2. Dunham-Bush, Inc.
3. McQuay, Inc.
4. Trane (The) Co.

5. Young Radiator Co.
6. Vulcan Radiator Corp.
7. Modine Mfgr. Co.
8. Sterling Radiator Co.
9. Rittling
10. Sigma Corporation.

B. General: Provide cabinet heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, motor starter switch and insulation.

C. Coil Section Insulation: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
1. Thickness: 3/4 inch.
2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect, baked-enamel finish with manufacturer's custom paint, in color selected by Architect.
1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessing Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.
6. Extended Piping Compartment: 8-inch-wide piping end pocket.
7. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.

F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

G. Fan and Motor Board: Removable.
1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.04 WATER COILS

A. General: Provide coils of size and in location indicated, and of capacities and having performance data as scheduled. Certify coil capacities, pressure drops, and selection procedures in accordance with ARI 410.

B. Heating Coils:
1. Fins: Construct of continuous aluminum or copper configurated plate-fin type with full fin collars for accurate spacing and maximum fin-tube contact.
2. Tubes: Construct of copper tubing, expanded into fin collars for permanent fin-tube bond and expanded into header for permanent leaktight joint.
3. Headers: Construct of round seamless copper tube. Hydrostatically test to 400 psi before assembly.
4. Casings: Construct of 16-ga continuous coated galvanized steel with fins recessed into channels to minimize air bypass.

5. Testing: Proof test coils at 300 psi, leak test at 200 psi under water.
6. Coil Types: Provide the following coil types as indicated, and as scheduled.
    a. Hot Water to 200 psi, 220oF: Provide 1 or 2-row, 5/8" tubes, same-end connection coil. Provide brazed tube-to-header joints.

2.05 MOTORS

A. Comply with requirements in Division 23 Section “Common Motor Requirements for HVAC Equipment”, including, but not limited to, efficiency and power factor correction requirements.
B. Permanently lubricated, multi-speed, resiliently mounted. For cabinet unit heaters, connect motor to chassis wiring with plug connection.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF FINNED TUBE RADIATION

A. General: Install finned tube radiation as indicated, and in accordance with manufacturer's installation instructions.
B. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window.
C. Install units level and plumb.
D. Install enclosure continuously around corners, using outside and inside corner fittings.
E. Join sections with splice plates and filler pieces to provide continuous enclosure.
F. Install access doors for access to valves.
G. Install enclosure continuously from wall to wall unless otherwise shown on the drawings.
H. Terminate enclosures with manufacturer's end caps, except where enclosures are indicated to extend to adjoining walls.
I. Install valves within reach of access door provided in enclosure.
J. Install piping within pedestals for freestanding units.
K. Install pipe supports per manufacturer's instructions. Supports shall attach to the adjacent walls where applicable. Pedestal enclosures shall utilize supports that attach to floors or other horizontal surfaces as indicated on the drawings.

3.03 INSTALLATION OF UNIT HEATERS

A. General: Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.
B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.
C. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.
D. Support units with rod-type hangers anchored to building substrate. Install units plumb and level.
E. Install piping as indicated.
F. Protect units with protective covers during balance of construction.

3.04 INSTALLATION OF CABINET HEATERS

A. General: Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions.
B. Locate cabinet heaters as indicated, coordinate with other trades to assure correct recess size for recessed units.
C. Install units plumb and level.
D. Install piping as indicated.
E. Protect units with protective covers during balance of construction.

3.05 INSTALLATION OF WATER COILS

A. General: Install coils as indicated, and in accordance with manufacturer's installation instructions.

B. Mount coils on steel supports to form banks or stacks as indicated, brace, secure to air intake chamber. Place in location to permit installation of bypass damper if required, provide steel baffles where required to prevent bypassing of air.

C. Pitch coil casings for drainage, not less than 1/8" toward return connections, except where drainage feature is included in coil design.

D. Provide for each hot water coil unit: Water supply, return connection, strainer, gate valves, automatic temperature regulating valve, balancing cocks, as indicated.

3.06 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Division 23 Section "Building Automation System."

D. Install piping adjacent to convection heating units to allow service and maintenance.

3.07 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.08 ADJUSTING AND CLEANING

A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filter units for terminals requiring it.

3.09 DEMONSTRATION AND TRAINING

A. Provide demonstration and training for Owner’s representative in accordance with Division 1 Section "Demonstration and Training."

END OF SECTION 23 82 33

SECTION 23 84 13
HUMIDIFIERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following humidifiers:
   1. Self-contained.

1.02 DEFINITION

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.03 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.
C. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members to which humidifiers will be attached.
   2. Size and location of initial access modules for acoustical tile.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.05 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.06 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 PRODUCTS

2.01 SELF-CONTAINED HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong International, Inc.
   2. Carel USA, LLC.
   3. Carnes Co., Inc.
   4. Herrmidifier.
   5. Hygromatik; Spirax Sarco, Inc.
   6. Nortec Industries Inc.
B. General: Provide humidifiers of size, capacity, and configuration as indicated on the drawings.
C. Electric-Resistance Heater Container: Cleanable, ASTM A 666, Type 316 stainless steel. Comply with UL 499.
D. Electrode Cylinder: Replaceable plastic assembly. Comply with UL 499.
E. Manifold: ASTM A 666, Type 316 stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends.

F. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.

G. Control Panel:
   1. Factory-wired disconnect switch.
   2. Liquid-crystal display.
   3. Programmable keyboard.
   4. Set-point adjustment.
   5. Warning signal indicating end of replaceable cylinder life.
   6. Low-voltage, control circuit.
   7. Diagnostic, maintenance, alarm, and status features.
   8. High-water sensor to prevent overfilling.

H. Controls:
   1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
   2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
   3. Field-adjustable timer to control drain cycle for flush duration and interval.
   4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
   5. Conductivity-type level controls.

I. Accessories:
   1. Duct-mounting, high-limit humidistat.
   2. Airflow switch for preventing humidifier operation without airflow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance.

B. Seal humidifier manifold duct or plenum penetrations with flange.

C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install stainless-steel drain pan under each manifold mounted in duct.
   1. Construct drain pans to comply with ASHRAE 62.
   2. Connect to condensate trap and drainage piping.
   3. Extend drain pan upstream and downstream from manifold a minimum of 24 inches or as recommended by manufacturer.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Install piping adjacent to humidifiers to allow service and maintenance.
   2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 84 13

SECTION 23 90 00
TESTING ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 SUMMARY

A. The testing, adjusting, and balancing contractor will be hired by the Mechanical Contractor for the work scope as defined under this specification section.

B. This Section specifies the requirements and procedures for mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, recording and reporting the results.

C. Test, adjust, and balance the following mechanical systems:
   1. Supply air systems.
   2. Return air systems.
   3. Exhaust air systems.
   4. Hydronic systems.
   5. Domestic hot water recirculation loop.

D. Test systems for proper sound and vibration levels.

E. This Section does not include:
   1. Testing boilers and pressure vessels for compliance with safety codes;
   2. Specifications for materials for patching mechanical systems;
   3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
   4. Requirements and procedures for piping and ductwork systems leakage tests.

1.02 DEFINITIONS

A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
   1. the balance of air and water distribution;
   2. adjustment of total system to provide design quantities;
   3. electrical measurement;
   4. sound and vibration measurement.

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

F. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

G. Terminal: The point where the controlled fluid enters or leaves the distribution system. There are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

H. Main: Duct or pipe containing the system's major or entire fluid flow.

I. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.

J. Branch main: Duct or pipe serving two or more terminals.

K. Branch: Duct or pipe serving a single terminal.

L. Construction Tests: Tests specified in other sections. Includes leak testing of piping and duct systems.

1.03 SUBMITTALS

A. Agency Data:
   1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.

B. Engineer and Technicians Data:
   1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.

D. Test and Balance Reports:
   1. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC, NEBB, TABB are proposed.
   2. Sample Forms: Submit sample forms, if other than those standard forms prepared by the NEBB are proposed.
   3. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
      a. Preliminary Reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports shall be submitted prior to Substantial Completion and include at a minimum documentation of required ventilation airflows and preliminary balancing of all primary supply air equipment including central air handlers, rooftop units, fan coil units and unit ventilators. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
      b. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports.
      c. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
         1) General Information and Summary
         2) Air Systems
         3) Hydronic Systems
         4) Temperature Control Systems
         5) Special Systems
         6) Sound and Vibration Systems
         7) Domestic Hot Water Recirculation Loop
      d. Report Contents: Provide the following minimum information, forms and data:
         1) General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the name, address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.

2) The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC and NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.

4. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.04 QUALITY ASSURANCE

A. Test and Balance Engineer's Qualifications: The on-site test and balance technician shall be NEBB or TABB or AABCcertified, be in the employ of the Test and Balance agency and have at least 3-years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.

B. Agency Qualifications: The testing, adjusting and balancing technicians and supervisor staffed to perform work on site shall be certified by the National Environmental Balancing Bureau (NEBB) or TABBor AABC in the following disciplines:
   1. Testing, adjusting, and balancing.
      a. Air
      b. Hydronics

C. Codes and Standards:
   1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".
   2. ASHRAE: ASHRAE Handbook, HVAC Applications. Testing, Adjusting, and Balancing.

D. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect and representatives of installers of the mechanical systems, and the Owner’s commissioning agent. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.05 PROJECT CONDITIONS

A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

1.06 SEQUENCING AND SCHEDULING

A. Coordinate all onsite inspections with the prime contractor.

B. Develop detailed work plan with the prime contractor, HVAC subcontractors, and Building Automation System contractor such that testing work will proceed in areas as systems are started and available.

1.07 SUBMITTALS

A. The Balancer shall coordinate with the Mechanical Contractor to receive all submittals for air handling and hydronic equipment prior to starting balancing. Balancing shall be completed based on final submittal information.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system, perform these steps:
   1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
   2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
   3. Compare design to installed equipment and field installations.
   4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
   5. Check filters for cleanliness.
   6. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
   7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

8. Determine best locations in main and branch ductwork for most accurate duct traverses.
9. Place outlet dampers in the full open position.
10. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
11. Lubricate all motors and bearings.
12. Check fan belt tension.
13. Check fan rotation.

3.02 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING

A. Before operating the system perform these steps:
1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean all strainers.
3. Examine hydronic systems and determine if water has been treated and cleaned.
4. Check pump rotation.
5. Clean and set automatic fill valve for required system pressure.
6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
7. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
8. Set temperature controls so all coils are calling for full flow.
9. Check operation of automatic bypass valves.
10. Check and set operating temperatures of chillers to design requirements.
11. Lubricate all motors and bearings.

3.03 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
B. Provide instruments meeting the specifications of the referenced standards.
C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
D. Apply instrument as recommended by the manufacturer.
E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
G. Take all readings with the eye at the level of the indicated value to prevent parallax.
H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
I. Take measurements in the system where best suited to the task.

3.04 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
C. Patch insulation, ductwork, and housings, using materials identical to those removed.
D. Seal ducts and piping, and test for and repair leaks.
E. Seal insulation to re-establish integrity of the vapor barrier.
F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

G. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
H. Air system balancing shall provide airflow rates within ± 10 percent of design capacities and fan speed shall be adjusted to meet design airflow conditions.
I. Hydronic system balancing shall provide flow rates within ± 10 percent of design capacities and pump impellers shall be trimmed or pump speed shall be adjusted to meet design flow conditions.

3.05 TESTING FOR SOUND AND VIBRATION

A. Testing, adjusting, and balancing work shall include an allowance of 16 hours to perform sound and vibration testing at the direction of the Engineer. The goal of the testing will be to identify corrective work such that all areas perform within the design sound levels. All resident and office areas are designed for a sound level of NC 35 or less. Sound testing shall be conducted in accordance with the referenced standards.

3.06 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.
C. Include an allowance of 8 hours per building location to provide re-testing and re-balancing at the direction of the architect/engineer. The goal of this re-testing and re-balancing will be to verify the performance of any corrective work and to help assure that all areas perform within the design range set for air and water flow rates.

3.07 DEMONSTRATION

A. Train Owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Refer to Division 01 Section "Demonstration and Training."
    1. Required Time: As required.

3.08 HVAC COMMISSIONING

A. Each Contractor shall cooperate and allocate appropriate time to complete all commissioning work. No additional costs will be allowed for required commissioning work. Refer to the DIV 01 specification section "General Commissioning Requirements".
    1. Contractor shall coordinate a meeting with a representative of the Owner, the Owner's commissioning agent, and the respective mechanical contractors as required, to re-check in everyone's presence, at least 10% of the terminal units, diffusers and coils.

END OF SECTION 23 90 00

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SCOPE

A. This section includes:
   1. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   4. Grout.
   5. Common electrical installation requirements.
   6. Sleeves and seals for raceways.
   7. Fire-stopping.
   8. Concrete bases.

B. This Section covers basic electrical requirements for providing labor, materials, equipment, and services necessary for the proper completion of all electrical work as shown on the drawings and specified herein. In general, this consists of wiring for light and power, installation of electrical systems, installation of lighting fixtures and any other equipment as hereinafter specified or required. Electrical work shall be complete with all documentation, wiring, conduit, fittings, equipment, and connections as specified or required. The omission of express reference to any items or work necessary for, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor from providing such items or work.

C. Conditions of the Contract (General and Supplementary Conditions) and Division 1, General Requirements, govern the Work of Divisions 26, 27 and 28 specification sections.

D. This section applies to all work in Divisions 26, 27 and 28 specification sections.

1.02 DEFINITIONS

A. The terms listed below are defined as follows only when used in Division 26, 27 and 28.
   1. Work: Labor and materials of the Contractor and/or Sub-contractor.
   2. Furnish: Obtain, coordinate, submit the necessary drawings, deliver to the job site in new condition and guarantee.
   3. Install: Receive at the job site, unload, store, set in place, connect, place in operation and guarantee.
   4. Provide: Furnish and install.
   5. Connect: Bring service to the equipment and make final attachment including necessary switches, outlets, connections, etc.
   6. Conduit: Includes, in addition to conduit, all fittings, pull boxes, hangers, and other supports and accessories related to such conduit.
   7. Concealed: Hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, in crawl spaces or buried.
   8. Exposed: Not installed underground nor concealed as defined above.
   9. The building structure or building structural members consist of steel columns, steel beams, steel joists (top chord and at panel points), concrete walls and concrete block walls. Metal decking, joist bridging and bottom chords of bar joists shall not be construed as building structure or as a building structural member for the purpose of support.

B. Provide Electrical work which is finished work, tested and ready for operation.
   1. Apparatus, appliances, material or work not indicated or any incidental accessories necessary to make the work complete and ready for operation, even though not specified nor shown on the drawings, are to be provided.
   2. Should there be any discrepancies or a question of intent, refer the matter to the Architect/Engineer for decision before ordering equipment or materials and before starting any related work.
   3. Where work connects to that of another trade, or to wiring or equipment in place, take measurements in the field to make connecting work come true and line up with the item being connected.

1.03 CONTRACTOR

A. The Contractor shall not employ a proposed project manager to whom the Owner or Engineer has made reasonable and timely objection. The Contractor shall not change the project manager without the Owner's consent, which shall not unreasonably be withheld or delayed.

1.04 INSPECTION OF SITE BEFORE CONSTRUCTION

A. Before submitting a proposal on the work contemplated, bidder shall examine the site of the proposed work and thoroughly familiarize himself/herself with existing conditions and limitations affecting the performance of his work. No extra compensation will be allowed because of misunderstanding as to the amount of work involved or the bidder's failure to verify existing conditions which he could have discovered or reasonably anticipated prior to bidding. Contractor shall be responsible for any additional cutting, patching, mounting or installation modifications, etc., not called out on the drawings but required for the successful completion of the job.

B. This includes any additional work required due to any existing jobsite condition (i.e., the construction of walls, ceiling spaces, clearances, available voltages, mounting requirements, existing equipment coordination, hazardous materials, etc) that the contractor had an opportunity to determine in the pre-bid walk-through and could have reasonably determined before the bid by visual inspection or by asking the Engineer or Owner. No additional money shall be awarded for additional work incurred caused by existing jobsite conditions which could have been verified by the contractor prior to bid. In addition, no additional money shall be awarded for failure to properly coordinate with other trades.

1.05 PLAN INTERPRETATION

A. The plans are diagrammatic and indicate the arrangement of systems and equipment unless indicated otherwise by dimensions or detail plans of 1/4" = 1'-0" scale of larger. Refer to dimensioned plans for exact locations of building elements. However, field measurements take precedence over dimensioned plans. Report any differences discovered between electrical plans and the plans for other divisions. The installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings.

B. Equipment outlines shown on detailed plans of 1/4" = 1'-0" scale or larger and/or dimensions indicated on the plans are limiting dimensions. Do not install any equipment that exceeds the equipment outlines shown or reduces indicated clearances.

1.06 SUBMITTALS

A. Provide the following submittals.

1. Shop Drawings shall be submitted for approval for equipment listed in the following Division 26, 27 and 28 sections.
2. Samples of equipment or system components shall be submitted for examination/approval as requested.
3. Instructions and Manuals. Provide on-site training and copies of instruction manuals to Owner designated personnel for operation, maintenance and warranty of electrical systems.
4. Test Reports. Reports shall be submitted outlining the results of testing performed for the installed equipment as described herein.
5. As-Built / Record Drawings. Keep layout plans for each system on the job site, marking changes made during installation. At completion of the project, this set of Record drawings shall be submitted as described herein.
6. Warranty. Warranty information shall be submitted upon project completion.
7. Rebates. Contractor shall provide all receipts as necessary for utility rebates and forward to Engineer / Owner. Contractor shall assist rebate application process by providing site data; including existing and proposed device / fixture counts and power usage.

1.07 PERMITS, LICENSES AND FEES

A. The Contractor shall secure all permits and licenses, both temporary and permanent required for his work. The Contractor shall pay all fees and expenses required for the permits and licenses.

1. The Contractor shall request inspections as required by regulating agencies and/or regulations. The Contractor shall pay all charges for inspections.

2. Contractor shall furnish the Owner with a certificate of final inspection and approval by enforcement authorities. Include a copy of all permits pulled, signed for completion, in closeout documents.
3. Comply with requirements of Division 00.
4. Refer to 26 27 01 Electrical Utility Coordination for requirements pertaining to Utility fees.

1.08 QUALITY ASSURANCE

A. Workmanship - All Work on each system complying with these Specifications shall be carried out and/or managed by a competent firm. The respective contractor(s) shall be regularly engaged in the installation and testing of the system that is their responsibility. If requested, the Contractor shall furnish evidence of its qualifications to perform the Work specified. Evidence may be a listing of major lines of equipment for which the Contractor is a dealer. This evidence may also include a list of projects of similar scope and size that the Contractor has performed, including names of contacts and phone numbers for each project.

B. Codes - Materials and workmanship shall comply with the most recently adopted applicable codes. As a minimum, codes include: All State and Federal laws, local ordinances, utility company regulations and requirements and recommendations of the following:
1. State and Local Building codes
2. Life Safety Code
3. International Building Code
4. State Energy Code
5. State Industrial Commission Regulations
6. State and Local Fire Codes and Regulations
7. International Fire Code
8. National Electric Code
9. State and Local Electrical Codes
10. Occupational Safety and Health Administration Regulations
11. Environmental Protection Agency
12. Facility Guidelines Institute
13. If these specifications with accompanying drawings are in any way at variance with these codes, the above cited codes shall govern and the Contractor shall make this installation accordingly, except where the drawings or specifications call for a higher quality of work than required by the Code.

C. Standards - These shall be used where referenced by the following abbreviations:
1. ADA: American Disabilities Act
2. AIA: American Insurance Association
3. AIA: American Institute of Architects
4. ANSI: American National Standards Institute
5. ASTM: American Society of Testing and Materials
6. EPA: Environmental Protection Agency
7. FM: Factory Mutual Insurance Association
8. FGI: Facility Guidelines Institute
9. IEEE: Institute of Electrical and Electronic Engineers
10. IES: Illuminating Engineering Society of North America
11. NBS: National Bureau of Standards
12. NECA: National Electrical Contractors Association
13. NEMA: National Electrical Manufacturers Association
14. NFPA: National Fire Protection Association
15. NEIS: National Electrical Information Standards
16. NSC: National Safety Council
17. OSHA: Occupational Safety and Health Act
18. TIA/EIA: Telecommunication Electronic Industry/Electronic Industry Association
19. UL: Underwriter's Laboratories

1.09 CORRELATION / COORDINATION OF WORK

A. Consult the drawings and specifications of Mechanical and other trades for correlating information and lay-out work so that it will coordinate with other trades. Verify dimensions and conditions (i.e. finished ceiling heights, footing and foundation elevations, beam depths, etc.) with the Architectural and Structural drawings. If conflicts occur such that resolution is not possible by the affected trades on the job, the Architect/Engineer shall be notified so that the proper changes can be made to avoid extra cost to the Owner.

B. Where work must be replaced due to the failure of the Contractor to verify the conditions existing on the job, such replacement must be accomplished at no cost to the Owner. This shall apply to shop fabricated work as well as to work fabricated in place.

C. Throughout the course of the work, minor changes and adjustments to the installation may be requested by the Engineer. The Contractor shall make adjustments without additional cost to the Owner, where such adjustments are necessary, to the proper installation and operation within the intent of the Contract Documents. This does not include work already completed.

D. Coordinate arrangement, mounting, and support of electrical equipment, so that connecting raceways, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

E. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Panels" and "Steel Doors and Frames."

G. Coordinate electrical service connections to components furnished by utility companies. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electric-metering components. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

H. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface. Where acoustical ceilings and similar finishes will conceal electrical identification markings and devices, coordinate installation of these items before ceiling installation.

I. Coordinate selection and application of firestopping specified in Division 07 Section "Firestopping".

1.10 CORRECTIVE PERIOD / GUARANTEE

A. The Contractor shall guarantee and maintain the stability of work and materials and keep same in perfect repair and condition for the period of one (1) year after the Date of Substantial Completion of the Project.

B. Defects of any kind due to faulty work or materials appearing during the above mentioned period must be immediately made good by the Contractor at his own expense to the entire satisfaction of the Owner and Architect and Engineer. Such reconstruction and repairs shall include damage to the finish or the building resulting from the original defect or repairs thereto.

C. This guarantee shall not apply to injuries occurring after final acceptance and due to wind, fire, violence, abuse or carelessness or other Contractors or their employees or the agents of the Owner.

D. This guarantee shall not apply where other guarantees for different lengths of time are specifically called for.

1.11 CONSTRUCTION LIGHTING AND POWER SYSTEM

A. Refer to Division 01 Temporary Facilities and Controls for construction lighting and power requirements.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Duly authorized distributors shall represent equipment and systems to be used on this project with service departments regularly engaged in the maintenance and installation of these systems and equipment. Such service departments shall regularly stock standard replacement parts and equipment and shall be located within a reasonable distance from the installation site.

2.02 MATERIALS

A. Materials and equipment shall be listed, labeled, or certified by a nationally recognized testing laboratory, such as Underwriters Laboratories (UL). Materials and equipment shall be of current production by a manufacturer regularly engaged in the manufacture of such items from which replacement parts shall be available. When items are specified by manufacturer's name or catalog designation, it shall be understood that this is to establish the class, features, quality rating, duty and, in the case of visible building elements such as lighting fixtures, service fittings, control panels, and the like, appearance. Materials shall be consistent (identical manufacturer and model, unless otherwise noted) throughout all phases of the project.

2.03 APPROVAL / SUBSTITUTION OF MATERIALS

A. Refer to General conditions and Division 01 for approval requirements.

B. Refer to General conditions and Division 01 for substitution requirements.

1. Where approved substitutes are used, the Contractor assumes responsibility for physical dimensions and other resulting changes. This responsibility extends to include extra work required by other trades as result of the substitution. Substituted equipment which requires additional costs by other trades in its application shall have such costs borne by the contractor furnishing the equipment.
2. The Contractor shall assume any costs associated with the replacement of a non-specified product, unapproved by the Engineer, with an as-specified product.

2.04 MATERIAL PROTECTION

A. Material and equipment shall be protected during shipment and storage against physical damage, dirt, moisture, cold, and rain. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items shall be protected against entry of foreign matter and be vacuum cleaned both inside and outside before testing and operating and repainting if required. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement. Damaged paint on equipment and materials shall be refinished to the satisfaction of the Engineer.

2.05 OWNER'S RIGHT OF RETENTION

A. Firmware, hardware, and software which is necessary to run the Project systems and/or equipment provided hereunder, shall become the property of the Owner. Such firmware, hardware, and software shall be upgradable and/or editable by the Owner to facilitate future functional changes and/or additions or deletions without cost or the need for second party software.

2.06 SLEEVES FOR RACEWAYS AND CABLES

A. Provide sleeves for all cables passing through walls and floors. Provide sleeves for conduits passing through floors, footings, and/or exterior walls. Provide sleeves for conduits 1-1/4" and larger passing through walls.

B. Provide sealing material at pipe sleeves that must be sealed against hydrostatic pressure, i.e. footing penetrations. Sleeve seals are usually furnished with EPDM sealing elements, plastic pressure plates, and carbon-steel bolts. NBR and silicone sealing elements, carbon- and stainless-steel pressure plates, and stainless-steel bolts are available for special applications.

C. Sleeves for penetrations through rated walls and floors shall conform to the requirements of Specification 07 84 00 "Firestopping".

2.07 FIRESTOPPING AND SEALS

A. Seal all openings around conduit or other electrical work penetrating fire and smoke rated partitions, floors, and ceilings. Firestop material shall comply with UL 1479, NEC 300-21, and NEC 800-3(c), and conform to the requirements of Specification 07 84 00 "Firestopping".

B. All sleeves and conduits penetrating walls built to deck require sealant. Refer to Division 07 Section "Sealants and Caulking" for materials and installation. Refer to Architectural Details for more information.

2.08 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. For interior applications, use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.
8. For exterior applications, use 4500-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 and 32.

PART 3 EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Material, equipment, or systems as shown and/or specified shall be new and installed in accordance with manufacturer's recommendations and industry standards as applicable. Electrical Work shall be installed in a professional, neat, workmanlike manner, as per NECA / NEIS. Electrical equipment shall be adequately and securely mounted and supported.
   1. Outdoor/Underground/Wet. All electrical Work installed where subject to the elements and/or water, wash down areas, shall be rated for such areas.
   2. Hazardous Locations. All electrical Work installed in classified hazardous areas, i.e. paint storage, shall be rated for such areas.
   3. Penetrations. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Resident Engineer prior to drilling through structural sections. Electrical Work installed between different environments shall be sealed to prevent moisture or contaminants from traveling from one area to another.
   4. Grounding / Bonding. Electrical equipment and materials shall be grounded and bonded in accordance with NEC Article 250 and as specified herein or on the drawings.
   5. Fireproofing. Electrical materials and equipment shall be installed so as to prohibit the spread of fire. Fire-stop wall, floor, and ceiling penetrations to the same fire-rating as the penetrated wall, floor, or ceiling.
   6. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
   7. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
   8. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
   9. Right of Way: Give to piping systems installed at a required slope.
   10. All labeling, identification or programming related to room numbering shall follow the Owner’s final room numbering scheme. Obtain documentation of Owner’s final room numbering prior to final labeling and/or programming. Identification of all systems shall utilize Owner’s final room numbers.

B. Cutting and Patching
   1. Perform and provide all cutting and patching of building materials as required for the installation of the work. No structural members shall be cut without the written approval of the Engineer/Architect and any such cutting shall be done in a manner satisfactory to the Engineer/Architect.

2. All patching of or repair of damage to work in place shall be done in a neat and workmanlike manner with the approval of the Engineer/Architect. The Contractor whose operations require cutting of work in place, or who cause damage which entails repairs of such work, shall employ mechanics of the particular trade whose work must be cut or which is damaged, and shall pay all costs of such patching or repair.
3. All holes through pre-cast concrete shall be drilled. Coordinate all pre-cast locations on the architectural and structural drawings.
4. Contractor shall be responsible for any additional cutting, patching, mounting/installation modifications, etc., not called out on the drawings but required for the successful completion of the job. This would include additional work required due to any existing jobsite condition (i.e., the construction of walls, ceiling spaces, clearances, available voltages, mounting requirements, existing equipment coordination, hazardous materials, etc) that the contractor had an opportunity to determine in the pre-bid walk-through and could have reasonably determined before the bid by visual inspection or by asking the Engineer or Owner. No additional money shall be awarded for additional work incurred caused by existing jobsite conditions which could have been verified by the contractor prior to bid. In addition, no additional money shall be awarded for failure to properly coordinate with other trades.
5. Grout – Non-metallic, shrinkage resistant grout: ASTM C 1107, factory packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

C. Excavation, Backfill, and Concrete
1. Provide trenching, excavation, and backfill required for the electrical work. Repair all streets, sidewalks, lawns, curbs or paved areas damaged during / due to work. Sub-surfaces and finished surfaces shall be constructed equal to existing conditions of adjacent materials.
2. Where concrete work is provided by the electrical contractor, concrete shall have compression strength of 4000-psi at 28 days and shall contain 4% to 6% air entrainment.

3.02 PENETRATIONS

A. Penetrations - Where raceways pass through fire partitions, fire walls, or smoke partitions, then provide firestopping seals as specified in Division 07 Section “Penetration Firestopping”.
B. Where multiple low-voltage conduits penetrate a full-height-to-structure partition (sound wall), and the area of such conduits is equivalent to or greater than (1) 4” conduit, then provide firestopping seals as specified in Division 07 Section “Penetration Firestopping”.
C. Roof Penetrations: Conduit penetrations directly through roof membrane are prohibited. Route conduits through equipment curb or provide roof penetration assembly per architectural details.
D. X-Raying of Penetrations
1. Where existing post-tension slabs are indicated all core drilling shall be preceded by x-ray of the core drilling area.
2. All masonry core drilling shall be preceded by x-ray of the core-drilling area.

3.03 FIRESTOPPING

A. Apply firestopping material to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.04 INSTALLATION OF SLEEVES

A. Coordinate sleeve locations.
1. Where raceways pass through floors, floors shall be core drilled and appropriately sized sleeves shall be installed. Sleeves shall terminate not less than 3 inches above floor slabs and not less than 3 inches below the ceiling of the floor below. Completely seal clearances between the raceway and sleeve, and make watertight. Low-voltage sleeves shall be bushed.
2. Schedule 40 pipe sleeves shall have at least three (3) concrete anchors.
3. Set all sleeves true to line, grade and position and plumb or level after concrete is poured. Correct any deviation from proper position.

4. Provide galvanized steel tube sleeve 1 1/2" larger than O.D. of conduit. Sleeve shall have wall thickness of 0.061 inches.
5. Where conduits pass through exterior concrete walls below grade, caulk both sides with oakum and lead wool or otherwise adequately waterproof the openings around the conduit.
6. Caulk spaces between pipe and floor sleeves inside the building with a waterproof caulking material. Spaces between pipe and exterior partition sleeves shall be caulked with fiber glass insulation.
7. Seal space outside of sleeves with grout for penetrations of concrete and masonry
8. Aboveground, Exterior-Wall Penetrations: Seal penetrations using pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
9. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.05 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products to be installed or turned over to Owner.

B. Store material and products in a clean and dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect products from dirt, water, construction debris, and traffic. Material and equipment shall be protected during shipment and storage against physical damage, dirt, moisture, cold, and rain. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items shall be protected against entry of foreign matter and be vacuum cleaned both inside and outside before testing and operating and repainting if required. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement. Damaged paint on equipment and materials shall be refinished to the satisfaction of the Architect/Engineer.

3.06 CLEAN UP

A. Contractor shall at all times keep the premises free from accumulation of waste material or rubbish caused by his employees or work. Upon completion of the work he shall remove his rubbish, tools, scaffolding, and surplus materials from and about the building, and shall leave his work areas "broom clean" or its equivalent. Electrical equipment shall be cleaned with temporary identification removed. In case of dispute the Owner will remove the rubbish and charge the cost to the Contractor.

B. After tests have been made and accepted, the Electrical Contractor shall go over the whole job and clean light fixtures, panels and other equipment installed by him/her, leaving the entire plant in a clean and complete working order.

3.07 PAINTING

A. Refinish all electrical equipment damaged during shipping and/or installation to its original condition. Remove all rust; prime, and paint per manufacturer's recommendations for finish equal to original.

3.08 FIELD TESTS AND ADJUSTMENTS

A. Work shall, upon completion, be subjected to such tests as are required under industry standards and/or specified herein. Acceptance of the Work by the Engineer shall be contingent upon satisfactory completion of these tests. Actual tests required shall be specified under their respective sections.

B. Prior to completion, the Work shall be subjected to a careful and thorough visual inspection to detect erroneous or loose connections, presence of foreign objects or materials, poor workmanship, incorrect ratings of overcurrent protective devices or equipment, compliance with drawings, or other abnormal conditions.

C. Tests shall be scheduled in advance so that a representative of the Engineer may be present. Test Reports shall be tabulated by the Contractor including the pertinent readings or observations, as well as a statement of the method and specific equipment employed, and shall be filed with the Engineer as part of the permanent Project record. In cases of test failure, it shall be agreed that the corrective measures proposed are adequate before making repairs. A second test shall be conducted upon completion of repairs, adjustments, or replacements.

D. The Contractor shall provide calibrated test equipment and temporary energy sources as required for tests.

3.09 SUBMITTALS

A. The Contractor shall submit the following information to the Engineer:

1. Shop Drawings shall be first checked by the Electrical Contractor for space/dimensional considerations, performance characteristics, and general conformance to these plans and/or specifications, and shall be so stamped.
    a. Shop drawings not stamped as specified will be returned to the Contractor without action. Contractor's stamp shall include his corporate name and address, the name of the checker, and the date. They shall then be sent to the General Contractor (as applicable) who will stamp them and forward to the Engineer.
    b. One copy of the shop drawings for any item shall be submitted to the Engineer for approval. Drawing size shall be no larger than 11" x 17".
    c. Submittals shall be grouped according to specification Section or categories and shall be labeled with the proper name of the project and specification Section. Partial submittals of a group or category will not be reviewed (e.g., submit all panels, all lighting fixtures, etc.).
2. Test Report. Copy of test report, as detailed above, shall be submitted.
3. As-Built / Record Documents. A set of construction documents shall be continuously marked during progress of construction to show actual circuit routing and makeup, equipment location changes, and variations between the project work, record-drawings, and the Contract documents. Such markings shall be made neatly and legibly with red felt-tipped pen. Submit with operation, maintenance and warranty data manuals.
4. Installation and Maintenance Manuals. Copies of Installation Instructions and Operation, Maintenance and Warranty Data Instruction Manuals shall be furnished for electrical equipment furnished. These Manuals shall include parts lists, troubleshooting methods, lubrication recommendations, and calibration instructions. Manuals shall be made up with hard cover post type binders such as Federal 'Super-Lok.' Large sheets shall be neatly folded and installed with posthole reinforcements such that the sheets will unfold without need to open binder posts. Manuals shall include index, section tabs, approved shop drawings, installation, operation, maintenance and warranty data instructions packed with equipment, parts lists, and any other data as necessary and/or appropriate for the user to have.
5. Software. Prior to project completion, and before final payment is made, the Contractor shall provide the Owner a hard copy printout of any PLC code and electronic media copies of PLC code and SCADA software, etc.

3.10 COMPLETION OF INSTALLATION

A. System Acceptance. System optimization shall be performed to make sure that each electrical system is properly installed and that all components are working properly. This shall include, but not be limited to:

1. Equipment is functioning properly.
2. Equipment is mounted in the correct location.
3. Equipment is rigidly and securely mounted.
4. Equipment is installed in a neat and visually professional manner.
5. Equipment is clean.
6. The training of operations personnel is complete.
7. Final Inspection. Upon completion of the work, notify the Engineer that the Project is complete and ready for inspection. The Engineer will schedule an inspection and generate a list of items to be corrected or completed before contract closeout. If the Engineer is requested to make a final inspection by the Contractor, and the Engineer finds work is not complete enough to perform that inspection, the Contractor will compensate the Engineer for their time. The Contractor will then perform the necessary work to complete the project and again request a Final Inspection.

B. Training. The Contractor shall furnish training for the operating and maintenance personnel of the Owner of the recommended and proper operation and maintenance of electrical systems. Training shall be both of the classroom type and the hands-on type, and shall cover all areas of maintenance and operation. Training shall be coordinated with the Engineer and Owner to allow videotaping, if requested by Owner.
   1. The training period may be either concurrent with the system start-up or follow the start-up period at the Contractor's option; however, if it is given concurrent to the start-up, then the instructing personnel shall be furnished in addition to the start-up personnel and one shall not interfere with the other.
   2. Actual training periods and their scopes shall be specified under their respective Section. Scheduling of the Owner's personnel shall be mutually agreed upon between the Contractor and the Project Engineer.

C. Cleanup. Keep the premises free from accumulation of waste material and rubbish. Remove debris from the job site and leave work areas broom clean upon completion of the work.

D. Spare Parts. Spare parts shall be turned over to the Owner at the completion of the Project. The spare parts shall not be used during start-up or warranty. Package spare parts for protection against dirt and moisture.

3.11 GUARANTEE (WARRANTY)

A. Unless specified in another Section, the warranty shall be described herein. The Contractor shall guarantee the equipment and systems to be free of defects in design, equipment, and workmanship for a period of one year from the date of acceptance as issued by the Architect’s certificate of completion. The Contractor shall replace, redesign, and correct any equipment that fails within the one-year period.

END OF SECTION 26 05 00

SECTION 26 05 03
ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SCOPE

A. This Section includes all labor, material, equipment, and services necessary and incidental to complete all the demolition and removal of all electrical systems as noted on the Drawings.

1.02 EXAMINATION

A. Examine the building to determine actual conditions and report any significant discrepancies with the Architect/Engineer for clarification. These examinations should include verifying field measurements, circuiting arrangements, and wiring that will be abandoned and that serves only abandoned equipment. Where new additions or penthouses are being constructed by this project that create openings in ceilings areas or roof, field visit the site to determine extent of conduit/wire relocation work and include in Bid.

B. Contractor shall assume in his bid that existing equipment and fixtures to be reused are in good working condition and can be installed without any repairs. If certain items are found to be in need of repair or in unusable condition, Contractor shall notify the Engineer for decision. However, Contractor shall be responsible for any damage caused by him to equipment in removal or handling.

C. The Electrical Contractor shall review the electrical equipment in and around the areas in which demolition work is to be performed. The Electrical Contractor shall submit a written list of items not working or broken to the Architect/Engineer. Upon completion of work, any electrical items not working or broken shall be the Electrical Contractor's responsibility to repair, unless noted on a list submitted prior to the start of demolition. If no such list is submitted to the Architect/Engineer prior to the start of demolition, the Electrical Contractor shall be made responsible to provide all equipment in working order at the end of the remodeling.

D. Contractor shall be responsible for any additional demolition not called out on the drawings but which is required for the successful completion of the job. This is work required due to an existing jobsite condition (i.e., the construction of walls, ceiling spaces, hazardous materials, etc) that the contractor had an opportunity to determine in the pre-bid walk-through and could have reasonably determined before the bid by visual inspection or by asking the Architect, Engineer, or Owner. No additional money shall be awarded for work caused by existing conditions which could have been verified prior to bid.

1.03 SUBMITTALS

A. Provide documentation of hazardous waste being turned over to a certified hazardous waste disposal company.

B. Provide written report of all findings where inspection is specified of existing equipment to be reused.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 EXECUTION

3.01 GENERAL INFORMATION

A. Provide demolition of all existing electrical facilities as shown on the drawings, or required. This includes, but is not limited to, lighting, power, and signal equipment. Existing electrical equipment to be reused is noted on the drawings.

B. Equipment, panelboards, and connections that are not intended to be demolished shall be maintained. Feeders and connections shall be protected and remain in use throughout the construction process.

3.02 CONTINUITY OF SERVICES

A. If the Owner will be occupying the existing building during construction, provide any temporary connections necessary to maintain services to the existing systems. Provide advance notice of a minimum of four weeks to the Owner of any temporary service outages. Advance notice shall be in writing with copies to the Engineer or Architect/Construction Manager.

B. Coordinate utility service outages with Power Utility Company.

C. Phase all demolition activities to coordinate with the general construction and other trades' schedules to minimize disruption to other trades and downtime to Owner.

D. Provide temporary wiring and connections to maintain continuity to existing systems in service during construction. Work must not be performed on energized equipment or circuits.
E. Refer to other specification sections for continuity of services and systems during construction.
F. Electrical circuit continuity shall be maintained where a device is removed from the circuit. Retrofit the circuit with conductors and raceways as required maintaining the connection to all devices that remain.
G. Where a wall is demolished and devices are shown on the demolition plans as being demolished, it shall be the responsibility of the contractor to relocate circuitry as needed to maintain connectivity to devices upstream and downstream.
    1. The Contractor shall bear costs associated with this work, including core drilling of floor, assuming the following conditions:
        a. The re-routing path is less than 40’ (combined horizontally and vertically).
        b. No cutting and patching of floor is required.
        c. The ceiling below is accessible.
        d. The conduit consists of 3/4" conduit or less containing branch circuitry with line voltage wiring, or low voltage wiring that can be spliced.
        e. The amount of rerouting required is not disproportional to the scope of the project.
    2. The Contractor may submit a claim for additional costs where conditions deviate from the above, such as longer route, cutting and patching is required, home runs or larger conduits are uncovered, etc.

3.03 DEMOLITION AND REMODEL WORK

A. Demolish and extend existing electrical work under Provisions of Section 02 41 19, "Selective Demolition" and this section, and as indicated on the Drawings. The Owner shall be offered materials and equipment slated for demolition. Legally dispose of all demolition material and equipment that the Owner has been offered but has not accepted.
B. Coordinate the demolition and/or installation of items by other trades to minimize the effect on existing electrical items to remain. E.C. shall relocate, reroute and/or replace materials needed to maintain existing electrical continuity and/or to maintain accessibility to j-boxes and other access points required by Code. Where modifications require new access panels, the E.C. shall provide them and coordinate size and location with other trades.
C. When connections to existing outlets (light fixtures, switches, receptacles, motors, other devices, etc) are removed, remove all unused wire and raceway, where accessible, back to last active outlet or source. Extend existing circuiting, if required, to continue circuiting to other areas.
    1. Devices. Remove all devices in areas that will be remodeled as shown on the drawings. Replace all devices and cover plates in outlets that shall remain. When outlets in walls, ceilings, or floors are being removed that are essential for the operation of other remaining outlets, provide new wiring devices in relocated outlets. Disconnect abandoned flush outlets and remove devices. Provide blank covers for all abandoned boxes and openings.
D. Lighting
    1. Remove all abandoned lighting fixtures in areas that are to be remodeled as shown on the drawings.
    2. Temporarily remove fixtures that are to be reconnected as shown on the drawings. These fixtures shall be cleaned and reinstalled with new ballasts and lamps. If conduit and wiring serving these fixtures must be removed to permit demolition work, provide new conduit and wire to obtain the same circuiting arrangement as originally existed.
    3. Wiring. Remove all wire wherever existing circuits are abandoned or modified. Install new conductors for all altered or remodeled circuits.
    4. Raceways. Remove abandoned raceways and boxes when exposed or when they interfere with new work of any trades, unless indicated or approved otherwise. When electrical materials are removed, patch and finish building surfaces to match existing finishes. If ceilings are exposed at any time during construction then abandoned raceways must be removed.

5. The Electrical Contractor shall remove / protect existing low-voltage cables in areas affected by the demolition. When remodeling is complete, the Electrical Contractor shall reinstall / remove protection of low-voltage cables and confirm all electrical devices and cables are restored to their original working conditions.
6. Permission. Obtain permission in writing from the Owner before interrupting services, branch circuits, communications, or other systems.

E. No portion of the electrical or communication systems may be abandoned in place. Remove all electrical material to a previous point of usage.

F. The existing distribution system shall be modified as indicated on the plans and specified herein. The revised system shall be complete and continuous with all superfluous equipment and connections which are not maintained to be removed.

G. Existing circuits to be extended beyond the existing wall, ceiling, or floor to be removed shall be replaced with new conduits and conductors as required. Reroute the existing circuit, or serve the remaining devices from another electrical source to maintain the circuit and device functionality.

H. Where ceilings are to be lowered and ceiling-mounted equipment, fixtures and devices are to be reused, extend cabling as required to new locations.

3.04 DISPOSITION OF EXISTING MATERIAL AND EQUIPMENT

A. All material and equipment, which is noted, specified, or required by the Owner to be salvaged, and is not scheduled to be reused or relocated, shall be carefully removed, delivered to the Owner, and stored where directed on site.
1. Carefully remove and store on site all material and equipment noted or specified to be reused or relocated. Thoroughly clean this equipment prior to installation.

B. Remove and properly dispose of all other materials or debris resulting from demolition operations from the site.

3.05 LAMP AND LIGHT BALLAST DISPOSAL PROCEDURE

A. The Contractor shall be responsible for disposing of the existing ballasts and lamps slated for demolition. Ballasts and lamps removed under this contract for demolition shall be kept intact, boxed and delivered to a certified hazardous waste disposal services and lamps to a certified hazardous lamp recycle service. Provide Owner with proper documentation for this work.

B. It is anticipated that no hazardous material, PCB ballasts, will be encountered; however, if some are found, they shall be packaged and stored on site for disposal by Owner and/or handled as described below.

3.06 DISPOSITION OF HAZARDOUS MATERIAL AND EQUIPMENT

A. The State of Minnesota requires all hazardous waste generators to have in place an Environmental Protection Agency (EPA) Identification Number prior to pick up and disposal of any hazardous waste, including PCB ballasts, fluorescent and HID lamps. No exceptions. Generators that need to apply for an EPA I.D. number can contact the Minnesota Pollution Control Agency in St. Paul (651-296-6300) and request an application form and the instructions for completing the form.

B. Dispose of hazardous waste as required by Environmental Protection Agency (EPA) and State and Local regulations. Hazardous waste may include but is not limited to PCB ballasts, fluorescent and HID lamps.

3.07 SALVAGED MATERIALS

A. All existing materials and equipment noted, specified, or required to be salvaged and which are not scheduled to be reused, shall be carefully removed and handled to minimize damage. The contractor shall be moved or delivered where directed by the owner.

B. All existing material to be reused shall be carefully removed and stored in a dry location to minimize damage.

3.08 CLEANING AND REPAIR

A. All patching of or repair of damage to work in place shall be done in a neat and workmanlike manner with the approval of the Engineer/Architect. The Contractor whose operations require cutting of work in place, or who cause damage which entails repairs of such work, including wall/paint finish, shall employ mechanics of the particular trade whose work must be cut or which is damaged, and shall pay all costs of such patching or repair.

B. Switchboards and Panelboards: For switchboards, panelboards, and other existing equipment that is modified within the project scope, de-energize and clean upon completion of project. Clean exposed surfaces and check tightness of electrical connections. Replace any damaged circuit breakers and provide closure plates for any vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: In areas of remodel clean existing luminaires on all exterior and interior surfaces and replace all lamps, ballasts, and broken electrical parts.

3.09 INSTALLATION

A. Reinstall relocated equipment and materials under the provisions of Division 01 and 02.

END OF SECTION 26 05 03

SECTION 26 05 19
ELECTRICAL POWER CONDUCTORS

PART 1 GENERAL

1.01 SCOPE

A. Section includes:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Testing and scanning.

1.02 SUBMITTALS

A. Product Data: For each type of product.
B. Samples of any or all proposed equipment or system components shall be submitted for examination/approval as requested.
C. Field quality-control reports.

1.03 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. ANSI / ASTM B3 – Annealed Bare Copper Conductor
   2. ICEA – Insulated Cable Engineer's Association
   3. NEMA WC 5 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
   4. NEMA WC 70 – Nonshielded Power Cables Rated 2000 Volts or Less
   5. UL 44 – Standard for Rubber-Insulated Wires and Cables (includes XHHW)
   6. UL 83 – Standard for Thermoplastic-Insulated Wires and Cables

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards. General Indoor Purpose = THHN/THWN; Outdoor in conduit = XHHW; Outdoor exposed = Sunlight resistant; Plenum rated; etc.

2.02 CONDUCTORS

A. Aluminum conductors for ampacity 100A and larger. Copper conductors for less than 100A or cycling loads like pumps and motors.
B. Conductors shall be UL listed.
C. The conductors shall be annealed (soft) copper having a conductivity of 98% pure copper, 600 volt minimum rating and meet or exceed all applicable ASTM, NEMA, UL, ICEA specifications.
D. Aluminum conductors shall have 600 volt minimum rating and meet or exceed all applicable ASTM, NEMA, UL, ICEA specifications.

2.03 SPLICES, TAPS, AND TERMINATIONS

A. Splices, taps and terminations shall be in accordance with UL and NEC.
   1. For conductors 8 AWG and smaller, provide "crimp-on" or "wire-nut" self-insulating connectors, 600V, 105-degrees C. Integral insulator shall completely cover exposed conductors.
   2. For copper conductors 6 AWG and larger, provide pressure or compression type connectors (indent, hex screw, or bolt clamp-type) with snap-on insulating covers.
   3. Reusable lever-operated push-wire connectors are allowed for listed applications. Non-lever push-wire connectors are prohibited.

2.04 METAL CLAD CABLE

A. Metal clad (MC) cable SHALL NOT be used on this project except for lighting whips (MC or MC-LED), unless specifically noted otherwise.

B. MC assembly shall include an insulated green equipment-grounding conductor, sized in accordance with the NEC. The outer metal armor or sheath of the assembly shall be approved and identified as an acceptable grounding return path.

1. Comply with NEMA WC 70 for metal-clad cable, Type MC.
2. Provide factory assembly of two or more current carrying copper conductors enclosed in a metallic sheath, aluminum or steel interlocked armor core or continuous, corrugated, aluminum tube.
3. Conductors and insulation shall conform to the requirements for single conductor insulated wire.
4. Anti-short bushings shall be installed per manufacturer.
5. Hospital grade MC shall have two grounding means and interlocking green armor.

PART 3 EXECUTION

3.01 GENERAL INFORMATION.

A. Conductors and cables shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Conductors 8 AWG and larger shall be stranded per N.E.C. No conductor smaller than 12 AWG shall be used unless specifically noted.

1. 600V Feeder Conductors - Type THHN/THWN in conduit.
2. Branch Circuit and Control Conductors - Type THHN/THWN in conduit.
3. 600V Feeder, Branch Circuit and Control Conductors Installed Underground or Outdoors in Conduit - Type XHHW.
4. Control Cable (Low-Voltage) – 600V, 16-gauge, plenum rated heavy-duty multi-conductor type, with PVC/nylon insulation over each conductor, color coded, and PVC overall jacket.
5. Lighting whips shall be hospital grade MC. Exceptions as follows:
    a. Standard lighting whips allowed for non-patient care areas like corridors and waiting rooms.
    b. Type MC lighting whips allowed for patient care areas when both the lights and associated controls (switch, dimmer, sensor, etc) is outside of the patient care vicinity. Outer armor shall be approved as acceptable grounding path.
6. Hospital grade MC cable is allowed for normal branch circuits.
7. Critical, life safety and equipment power branch circuits shall be in metallic conduit per above.

C. Cord Drops and Portable Appliance Connections – Type SO, hard service cord with stainless-steel, wire-mesh, strain-relief device at terminations to suit application.

D. All home runs and feeders shall be in conduit.

3.02 INSTALLATION OF CONDUCTORS

A. General:

1. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
2. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

B. Installation of 600V Conductors (>100V)

1. Install conductors in accordance with the NEC and as specified. Install all wiring in raceway systems unless specified otherwise.
2. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
3. Conductors shall not be pulled in by any manner likely to injure the insulation. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
4. Swab underground raceways, 1-1/4” and larger, with sponge and drawstring before conductor installation.

5. Splice conductors only in outlet boxes, junction boxes, pull boxes, manholes, or handholes.
6. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
7. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form and train the conductors.
8. Seal conductors with a non-hardening approved compound at transitions between two different temperature locations. I.E. Entering a building from underground.
9. All conductors are 12 AWG copper unless indicated or specified otherwise. All conductor sizes indicated on the drawings are based on copper conductors. Do not substitute smaller conductors with higher temperature rated insulation. Verify conductors are sized per 3% energy code voltage-drop requirements.
10. Maximum number of conductors in raceways and boxes shall conform to the latest edition of the National Electrical Code with the following exception: Do not fill 1/2" conduit to more than 25% fill.
11. All line to neutral loads shall have dedicated neutrals, separate neutrals for each phase conductor.
12. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
13. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches of slack.
14. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
15. Multiwire branch circuits are prohibited.
16. Secondary service, feeder, and branch circuit conductors shall be color coded as follows:

208/120 Volt		Phase	480/277 Volt	
Ungrounded	Neutral		Ungrounded	Neutral
Black	White / Blk tracer	A	Brown	Gray / Brown tracer
Red	White / Red tracer	B	Orange	Gray / Orange tracer
Blue	White / Blue tracer	C	Yellow	Gray / Yellow tracer

C. Installation of Control Voltage Conductors (<100v).
1. Install conductors in accordance with the NEC, and as specified. Wiring splices shall be avoided and, if necessary, must be installed only in junction boxes. (Instrumentation and shielded control cables shall be run continuous from origin to termination.) All system junction boxes and any spliced cable must be labeled. Neatly form and train the conductors inside control panels.
2. Cables shall be installed in conduit in the following locations:
   a. Where required by a system specification or plan note.
   b. Where cables are subject to physical damage or in corrosive atmospheres.
   c. Where cables are concealed within inaccessible walls or ceilings.
   d. In mechanical spaces and exposed storage areas.
   e. On existing unfinished walls below structural ceiling.
3. Where systems are allowed to be free-air, plenum rated cabling may be installed without a raceway as follows:
   a. Align and run cables parallel or perpendicular to the building lines. Cable shall be supported at least every 5 feet. Whenever possible, cables shall be grouped together. Install horizontal runs close to the ceiling, beams, or structure and secure with appropriate supports. Cable shall be independently supported by cable tray, dedicated j-hooks, or equivalent (tie-wraps are not equivalent). Cable shall not tie off to other conduits or devices.
   b. In a False Ceiling Environment, cable supports shall be mounted a minimum of 3” above the ceiling grid supporting the false ceiling. Cables routed in a suspended ceiling shall not be draped across the ceiling. Cable supports shall be provided by means that are structurally independent of the suspended ceiling, its framework, or supports.
   c. Cabling, which runs parallel with electric power or lighting, conduits/conductors and is less than or equal to 480V, shall be installed with a minimum clearance of 2”.
   d. Cabling shall maintain a minimum clearance of 10’ from power cables in excess of 480V.

e. Cabling must not be supported by ductwork or piping.
f. Cabling must be installed to allow for seasonal building expansion and contraction.
g. The Contractor shall observe the manufacturer's bending radius and pulling strength requirements of the cable during handling and installation.
h. The Number of Horizontal Cables placed in a cable support or pathway shall be limited to the number of cables that might cause a deformation of the standard geometric shape of the cables.
i. Cable Penetrations through partitions or walls shall be provided with a sleeve and appropriate sealants where required.

3.03 INSTALLATION OF MC CABLE

A. For Luminaires: MC and MC-LED cables are allowed as branch-circuit wiring from junction boxes to luminaires. Daisy chaining of luminaires with cable is prohibited. There shall be a maximum of four MC terminations per junction box.

B. Cable shall not be used in exposed locations. Cable shall only be used for:
1. Branch circuit wiring (maximum of 10') between receptacle boxes (maximum of two boxes) inside metal stud walls. The supply into back box inside metal stud wall shall be conduit.
2. MC cable shall not be utilized for feeders.

C. MC Cable Installation:
1. Install conductors in accordance with the NEC and as specified. Flattened, dented, deformed, or opened armor is not permitted. If damaged during installation, damaged cables shall be replaced with new undamaged material. Cut square with manufacturer's armor stripping tool and remove burrs. Remove enough armor from cable to permit sufficient conductor to extend into the enclosure. Cable shall be mechanically and electrically continuous. Secure cable to equipment, junction boxes, and outlet boxes with fittings approved for grounding. Cables shall be run parallel or perpendicular to the building lines.
2. Bends. Bends shall be made so that the cable is not damaged. The radius of the curve of the inner edge of any bend shall not be less than five times the diameter of the cable.
3. Cable Supports. The cable shall be secured by approved straps, hangers, or similar fittings designed and installed as to not damage the cable. Independently support the cable or install in cable trays. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts.
4. Where cable trays are used to support the cables, each cable shall be securely fastened to transverse members of the cable trays. Cable trays shall be independently supported in accordance with manufacturer's recommendations and NEC.

3.04 SPLICES, TAPS, AND TERMINATIONS

A. Install electrical connectors and terminals according to manufacturer's published instructions.
1. Splice / terminal connections shall be mechanically and electrically secure.
2. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
3. Installation of compression connectors shall be with manufacturer recommended tools. The crimper shall be mated to the crimp.
4. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.
5. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
6. Terminate spare conductors with wire nuts and electrical tape.

3.05 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

C. Coordinate selection and application of sleeve seals as specified in Division 07 Section “Firestopping”.

3.06 FIRESTOPPING

A. Coordinate selection and application of firestopping specified in Division 07 Section “Firestopping”.

3.07 FIELD QUALITY CONTROL

A. Contractor shall field inspect and test conductor installation as follows.

1. Inspect wire, cable, and/or cord for physical damage and proper connection / termination.
2. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning conductors and cables at project site, where possible, and re-test to demonstrate compliance; otherwise, remove and replace with new units and retest.

B. Tests and Inspections:

1. After installing conductors and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding critical equipment and services for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Continuity Testing:
    a. Prior to energizing, test wires and cables for electrical continuity, short-circuits and grounds. Verify proper phasing connections.
4. Infrared Scanning:
    a. After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    c. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    d. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
4. Include results in the Operation, Maintenance and Warranty Data Manuals.

D. Remove and replace or re-terminate malfunctioning conductors and retest as specified above.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This Section covers basic electrical requirements for providing labor, materials, equipment, and services necessary for the proper grounding and bonding of electrical work as shown on the drawings and specified herein.
   1. Grounding conductors and connectors.
   2. Grounding bus bar.
   3. Grounding electrodes.
   4. Telecommunications Bonding and Grounding.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for approval for equipment as follows:
   1. Grounding bus bar.
   2. Technology bonding busbars:
      a. Primary Bonding Busbar (PBB).
      b. Secondary Bonding Busbar (SBB).
      c. Submit riser diagram for the Telecommunications Bonding and Grounding system.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inclusion in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Riser diagram for the Telecommunications Bonding and Grounding system.
   2. Test Data: Results of grounding test results.

1.04 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. ANSI / ASTM B3 & B8 – Annealed Bare Copper Conductor
   2. ANSI/TIA-607-C: Generic Bonding and Grounding (Earthing) for Customer Premises
   3. BICSI TDMM 13th Edition Chapter 8 – Bonding and Grounding (Earthing)

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 GROUNDING CONDUCTORS AND CONNECTORS

A. Conductors:
   1. Insulated Conductors: Copper wire insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
   2. Bare Copper Conductors: ASTM / UL.
   3. Telecommunications Bonding and Grounding conductors:
      a. Shall be sized according to requirements in ANSI/TIA-607-C.
      b. Conductors from the Primary Bonding Busbar (PBB) and Secondary Bonding Busbar (SBB) to non-current carrying metals shall be minimum of 6 AWG.

B. Connectors:
   1. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
   2. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted-pressure-type, with at least two bolts
   3. Pipe Connectors: Clamp-type, sized for pipe.
   4. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
   5. Telecommunications Bonding and Grounding Connectors:
      a. Terminations at the telecommunications grounding busbar shall be made with dual-hole, dual-crimp lugs with two hex-head bolts, properly crimped using crimping/swaging tool and tightened to meet manufacturer's torque specifications. Phillips-head screws are not acceptable.
      b. Lugs shall be manufactured of tin plated copper and fastened via irreversible compression (crimped) and shall have spacing to fit an ANSI/TIA-607 standards compliant predrilled busbar.
      c. Approved Lugs: Panduit LCC or LCCX series or equivalent
      d. HTAPs shall be contained in clear covers that allow inspection of the die marks to ensure that the proper die was used.
      e. Approved HTAPs: Panduit HTWC series or equivalent

2.03 GROUNDING BUS BAR

A. Grounding Bus Bar: Rectangular bars of tin-plated copper, 1/4 by 4 inches in cross section, unless otherwise indicated; with insulators.

2.04 TELECOMMUNICATIONS BONDING BUSBARS

A. ANSI/TIA-607 pattern, predrilled copper busbar with holes for use with two-hole lugs. Minimum dimensions of .25 inches thick by 4 inches wide. Length sized appropriately to the application with 150% growth. PBB and SBB shall have insulators and mounting brackets.
B. Must be listed by a Nationally Recognized Testing Laboratory (NRTL).
C. Approved manufacturer: Panduit GB4B series or equivalent.

2.05 GROUNDING ELECTRODES

A. Grounding Rods:
   1. Ground Rods – Copper clad steel, ¾" diameter, 10' long.

PART 3 EXECUTION

3.01 GENERAL INFORMATION

A. Grounding shall be in accordance with NEC Article 250.
B. Grounding and bonding shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
C. Equipment grounding conductors shall be installed in all conduits.

3.02 APPLICATIONS

A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
   1. Provide ground wire in all raceways as the equipment ground conductor.
   2. Conductors: Install solid conductor for No. 14 AWG and smaller, and stranded conductors for No. 12 AWG and larger, unless otherwise indicated.
B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
   1. Bury at least 24 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, except as otherwise indicated.
   3. Connections to Structural Steel: Welded connectors.

D. Grounding Bus Bar: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on Drawings.
   1. Install bus on insulated spacers 1 inch minimum, from wall, 6 inches above finished floor, unless otherwise indicated.

E. Grounding at Services (including at Stepdown Transformer Secondaries): Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

F. Generator Grounding:
   1. Non-Separately Derived Generators, Connected with 3-Pole Transfer Switch: Ground generator at its ground grid connected to the building service ground. Provide ground conductors and bond the generator to the electrical service per NEC.
   2. Separately Derived Generators, Connected with 4-Pole Transfer Switch: Install grounding electrode in the form of ground rod at the generator location to establish separately derived ground at generator. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

G. Bonding of Piping Systems and Exposed Structural Steel: Where required by NEC to be grounded, provide bonding in accordance with NEC paragraph 250.102. (Including bonding to separately derived system.)

H. Signal and Communications: For telephone, alarm, and communication systems, provide a No. 4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal cabinet or central equipment location.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide equipment grounding conductor from panel to pole. Provide ground rod below grade near base of pole, or utilize concrete base as grounding electrode. Bond equipment grounding conductor with grounding electrode, pole ground lug and luminaire ground.

J. Bonding of Building Additions:
   1. Where new building additions are included in project scope, bond new and existing steel structures together to form common ground potential.

K. Grounding at Pools and Saunas:
   1. Pools and Sauna: Provide grounding per NFPA 70. Provide corrosion proof equipment for all electrical equipment located with pools, pool mechanical room and sauna.
   2. Provide corrosion proof equipment (including anchoring equipment, hardware, fittings, coverplates, etc.) for all electrical equipment located within the pool, pool mechanical room and sauna. Provide non-ferrous stainless steel 304 grade or better or aluminum equipment. Ferrous metal equipment is not allowed.

3.03 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Provide ground rod, and grounded neutral or grounded phase conductor, to ground supply transformer to meter socket and each service disconnection means, or as required by Utility.

3.04 INSTALLATION

A. General: Ground electrical systems and equipment in accordance with NEC requirements, except where the Drawings or Specifications exceed NEC requirements.

B. Grounding Electrode System: Provide and install grounding electrode systems according to NEC Article 250. Route insulated grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated. Bond the following items together to form the service entrance ground:

1. Main water service piping (and associated supplemental ground rod).
    a. Metallic Water Service Pipe: Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground-clamps/connectors. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fitting. Do not install a grounding jumper around dielectric fittings. Bond the ground conductor conduit to the conductor at each end.
    b. Ground Rods: Provide ground rod to achieve 25 ohms ground. Provide additional ground rods if required to achieve 25 ohms. Locate a minimum of two-rod lengths from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors buried at least 24 inches below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Use ground rods as noted above except as otherwise indicated. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated.
2. Building steel. Connect ground electrode structural steel components that is connected / bonded to earth.
3. Concrete encased electrode (Ufer).
    a. Ufer Ground (Concrete-Encased Grounding Electrode) Footing Steel: Fabricate with 20 feet of conductor laid lengthwise in excavation for foundation or footings. Install so conductor is within 2 inches of the bottom of the concrete. Where base of foundation is less than 20 feet in length, coil excess conductor at base of foundation. Bond conductor to reinforcing steel at four locations, minimum. Extend conductor below grade and connect to building grounding grid or grounding electrode.
4. Secondary Bonding Busbar (SBB): Provide bonding busbar supported 96 inches above finished floor, except as otherwise indicated.

C. Bonding:

1. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
2. Bond interior metal piping systems and metal air ducts to equipment ground conductors of pumps, fans, electric heaters, and air cleaners serving individual systems.

3.05 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.
7. Armored and metal-clad cable runs (where cables are allowed by Section 260519 Low-Voltage Electrical Power Conductors and Cables).
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.06 CONNECTIONS

A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Provide electroplated or hot-tin-coated materials to assure high conductivity.
2. Make connections with clean bare metal at points of contact.
3. Make copper to steel connections with stainless steel separators and mechanical clamps.
4. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

B. Exothermic Welded Connections: Use for connections to structural steel and for underground connections except those at test wells. Provide at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations and instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.

D. Tighten screws and bolts for grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torque requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

E. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

F. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

G. Equipment Grounding - Wire Terminations: For No. 12 AWG and larger, use pressure-type grounding lugs; for No. 14 AWG and smaller grounding conductors, terminate with winged pressure-type connectors.

H. Telecommunications Grounding and Bonding
1. General Requirements:
a. The grounding/earthing system shall be intentional, visually verifiable, and adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment.
b. Building steel and metallic water piping may not be substituted for the telecommunications bonding backbone (TBB).

2. Bonding conductors shall:
    a. Run without splices between termination points
    b. Avoid unnecessary loops
    c. Not have sharp bends
    d. Not be excessive in length
    e. Run directly as possible
    f. Be terminated at each end using UL-listed termination methods
    g. Have inspection windows allowing for connections to be inspected for full conductor insertion
    h. Have die index numbers embossed on all compression connections to allow crimp inspection.
    i. Have solid mechanical compression terminations that are irreversible.
    j. Have bonding hardware that breaks through paint and powder coatings to make solid, reliable contact with the metal substrate.
    k. Have terminations at the grounding busbar made with dual-hole, dual-crimp lugs with two hex-head bolts, properly crimped using crimping/swaging tool and tightened to meet manufacturer's torque specifications. Phillips-head screws are not acceptable.
    l. Use antioxidant when making bonding connections in the field
    m. Be no smaller than No. 6 AWG and green in color.
    n. Be labeled to identify the termination point of the opposite end of the conductor.
3. Grounding and Bonding Conductors shall be appropriately sized according to requirements in ANSI/TIA-607-C: Generic Bonding and Grounding (Earthing) for Customer Premises.
4. Telecommunications Grounding Busbar shall be sized to allow for at least 150% additional unused terminal spaces for future use after the project has been completed.
5. Provide a #6 AWG bonding conductor between the grounding busbar in the technical power panel and the Secondary Bonding Busbar (SBB).
6. Bond all non-current-carrying metallic components to the Telecommunications Bonding and Grounding system, including, but not limited to, equipment, racks, ladder racks, enclosures, cable trays, etc.
7. Individual segments of ladder rack and cable tray must be bonded together to form an electrically continuous installation. All bonding and grounding components must be approved by the cable support system manufacturer.
8. Any metallic conduit that carries a grounding conductor and is greater than 3 feet long shall have both ends bonded to the conductor with a bonding jumper no longer than 12 inches, fastened with a compression HTAP to the conductor on one side and to the conduit on the other.
9. Refer to drawings for grounding riser.

3.07 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports. Testing to be done in presence of design engineer/commissioning agent.
    1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
    2. Test completed grounding system at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.
        a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
        b. Perform tests by the 2- point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System."

B. Report measured ground resistances that exceed the following values:
   1. System with Capacity 500 kVA and Less: 10 ohms.
   2. System with Capacity 500 to 1000 kVA: 5 ohms.
   3. System with Capacity More Than 1000 kVA: 3 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.08 ADJUSTING AND CLEANING

A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform such Work in accordance with Division 2 Section "Landscape Work." Maintain disturbed surfaces. Restore vegetation in accordance with Section "Landscape Work." Restore disturbed paving as indicated.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.
   3. Pipe/conduit stands.

B. Summary: This Section includes the furnishing and installation of hangars and supports for electrical equipment and systems. The contractor shall design and provide supports for single and multiple raceway installations. The contractor shall also design and provide supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.02 REFERENCES

A. UL, Building Materials Directory.

B. Welding-Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. MFMA – 4 Metal Framing Manufacturer's Association.

D. MSS SP-58 - Manufacturers Standardization Society of the Valve and Fittings Industry.

E. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.

1.03 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

1.04 SUBMITTALS

1. Not required.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All hangers and supports for electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems, MFMA-4, with manufacturer recognized fittings and accessories. 12 gauge "U" section, 1-1/2" square nominal.

B. Threaded rod: Zinc plated steel, 3/8" diameter minimum sized to support load with safety factor of 2.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for electrical conductors in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

H. Structural Support Systems in Corrosive Atmospheres (including but not limited to pools, pool mechanical rooms, saunas, etc.): Provide corrosion proof equipment (including anchoring equipment, hardware, fittings, coverplates, etc.) for all electrical equipment located within rooms. Provide non-ferrous stainless steel 304 grade or better or aluminum equipment. Ferrous metal equipment is not allowed.

2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.04 CONCRETE BASES

A. For interior applications, use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.

B. For exterior applications, use 4500-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 and 32.

C. Concrete materials, reinforcement, and placement requirements are specified in Division 03 and 32 (as applicable).

PART 3 EXECUTION

3.01 GENERAL INFORMATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

3.02 METHODS AND LOCATIONS OF HANGERS AND SUPPORTS

A. Ceiling support wires shall not be utilized to support power, signaling or communications raceways or cables. Independent support wires used for support can be attached to a nonfire-rated assembly. These support wires shall be distinguishable by color, tagging or similar method.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through-bolts.
2. To New Concrete: Bolt to concrete inserts. Drill holes for anchors in concrete at locations and to depths that avoid reinforcing bars.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
   a. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock-washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater.
   b. Verify with Owner the use of powder-actuated anchors.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps complying with MSS SP-69 or spring-tension clamps (for up to 1-1/2”).
6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF HANGERS AND SUPPORTS

A. Surface mounted cabinets and panelboards: Provide a minimum of four anchors. Provide steel channel supports to stand cabinet one inch off of wall, or on ¾" painted (all sides) plywood backboard.

B. Flush mounted cabinets and panelboards: Provide bridging, top and bottom, between studs in wall.

C. Miscellaneous Equipment: Do not fasten hangars or supports to piping, ductwork, mechanical equipment, or other electrical conduit.

D. Roof:

1. Support equipment and luminaires from the top chord of bar joists. Connect at bar joist top chord panel point, junction of vertical or angular member to top chord.
2. Unless otherwise noted on the plans / drawings, do not support equipment from roof deck.
3. Raceway and junction box installation installed under roof decking shall be supported so that nearest outside surface of the raceway is not less than 1-1/2" from the nearest surface of the roof decking.

E. Concrete Housekeeping Pads: Install free-standing electrical equipment on 4" pad that overlaps equipment footprint by 2" on all sides.

3.04 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.05 INSTALLATION OF CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.06 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

B. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

C. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing, installation, and connection of conduit, fittings, and boxes for a complete grounded raceway system.
   1. Conduits, tubing, and fittings.
   2. Metal wireways and auxiliary gutters.
   3. Surface raceways.
   4. Interior outlets and junction boxes.
   5. Boxes, enclosures, and cabinets.
   6. Handholes and boxes for exterior underground cabling.

B. Related Sections:
   1. 26 27 26 “Wiring Devices” for floor boxes, poke-throughs and multi-outlet assemblies.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for approval for equipment as follows:
   1. Surface Raceway.
   2. Handholes.

B. Samples of any or all proposed equipment or system components shall be submitted for examination/approval as requested.

C. Record Drawings. The Contractor shall keep layout plans on the job site, marking all changes made during installation. A set of As-Built / Record drawings shall be submitted.

1.03 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. ANSI C80.1 – Rigid Steel Conduit, Zinc Coated
   2. ANSI C80.3 – Electrical Metallic Tubing, Zinc Coated
   3. ANSI C80.5 – Aluminum Rigid Conduit
   4. ANSI C80.6 – Intermediate Metallic Conduit
   5. ANSI/NEMA FB-1 – Fittings and Supports for Conduit and Cable Assemblies
   6. NEMA 250 Enclosures for Electrical Equipment (1000V Maximum)
   7. NEMA OS 1 – Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports
   8. NEMA RN-1 – PVC Externally-Coated Galvanized Rigid Steel Conduit
      a. NEMA TC2 – Electrical Plastic Tubing and Conduit
   9. NEMA TC3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing
   10. UL, Building Materials Directory
   11. UL 5 – Surface Metal Raceways and Fittings

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory’s label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards. General Indoor Purpose = NEMA1, Outdoor = NEMA 3R, etc.

2.02 CONDUIT AND FITTINGS

A. Rigid non-metallic conduit (U.L. Standard UL-651, A.N.S.I. Standard F512, NEMA Standard TC-2, Federal Specifications GSA-FSS and W-C-1094-A):
   1. Provide schedule 40 PVC Conduit installed in accordance with NEC Article 352 for underground and exposed use and shall be used underground in or beneath slabs on grade, in crawl spaces and tunnels, and in exterior exposed locations unless noted otherwise. Schedule 80 shall be used in bored and under roadway/parking locations or as specified herein or on the drawings. Raceway supports shall be PVC or PVC-coated.

B. Rigid PVC coated rigid steel conduit:
   1. Conduit, 40mil PVC coated, shall be used for transition from underground or underfloor to exposed locations. The transition shall be made underground or underfloor to 24" AFG or AFF.
   2. Provide threaded type fittings, couplings, and bushings for rigid PVC coated steel conduit with the same coating as the conduit. Provide brush-on PVC touch-up compound.

C. Flexible metallic conduit (U.L. Standard UL-1):
   1. Provide flexible conduit, installed in accordance with NEC Article 348, for connections to motors, transformers, other rotating or vibrating equipment, and recessed lighting fixtures, but not over 6'-0" in length unless noted otherwise.
   2. Provide Type U.A., hot-dip galvanized, flexible steel conduit tubing. Provide steel or malleable iron type fittings, couplings, and bushings for flexible metallic conduit. Cast type devices are not acceptable.

D. Liquid-tight flexible metal conduit (U.L. Standard UL-360):
   1. Provide liquid-tight flexible conduit, installed in accordance with NEC Article 350, for connections to rotating or vibrating equipment outdoors in wet or damp locations, or in corrosive atmospheres, but not over 6'-0" in length unless noted otherwise.
   2. Provide Type U.A. flexible conduit covered with an extruded, polyvinyl chloride sheath. Provide steel or malleable iron, water-tight type fittings, couplings, and bushings approved for use with liquid-tight flexible metal conduit.

E. Rigid steel conduit (U.L. Standard UL-6, A.N.S.I. C80-1, Federal Specification WW-C-581E):
   1. Provide rigid steel conduit as required for applications not covered above and in accordance with NEC Article 344.
   2. Provide hot-dip galvanized or electro-galvanized, inside and outside, rigid steel conduit having a bichromate finish. Threads shall be zinc coated. Provide threaded type fittings, couplings, and bushings for rigid steel conduit.

F. Rigid aluminum conduit (A.N.S.I. C80.5):
   1. Provide rigid aluminum conduit as required for applications not covered above (A-E) and in accordance with NEC Article 344.
   2. Provide rigid aluminum conduit conforming to U.L. and ANSI standards. The inside shall have a wax or similar coating to facilitate pulling. Provide threaded type fittings, couplings, and bushings for rigid aluminum conduit.

G. Intermediate metal conduit (IMC) (U.L. Standard UL-1242, Federal Specification WW-C-581E):
   1. Provide intermediate metal conduit as required for applications not covered above (A-E) and in accordance with NEC Article 342.
   2. Provide hot-dip galvanized, intermediate metal conduit. Provide threaded type, concrete-tight split couplings, concrete-tight steel compression type, or concrete-tight steel set-screw type fittings, couplings, and bushings for intermediate metal conduit. Cast type devices are not acceptable.

H. Electrical metallic tubing (EMT) (U.L. Standard UL-797, A.N.S.I. C80-3, Federal Specification WW-C-563):
   1. Provide electrical metallic tubing as required for applications not covered above (A-E) and in accordance with NEC Article 358.
   2. Provide electro-galvanized, electrical metallic tubing. The interior shall have a smooth coating of aluminum lacquer or enamel. Tubing shall not be threaded. Provide concrete-tight steel compression or set-screw type fittings, couplings, and bushings for electrical metallic tubing. Cast or indenter type devices are not acceptable.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 (Type 3R for damp or wet locations) unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
C. Wireways shall be provided without knockouts and shall have hinged type covers.
D. Finish: Manufacturer's standard enamel finish.
E. Provide "lay-in" type wireway with lengths and connectors hinged to provide unobstructed lay-in of conductors. All fittings must be so constructed to continue the "lay-in" feature through the entire installation.
F. All sheet metal parts shall be provided with a rust-inhibiting phosphatizing coating and finished in baked enamel. All hardware shall be plated to prevent corrosion.
G. All lengths, connectors and fittings shall be U.L. labeled and installed in accordance with NEC Article 366, and 376 (Auxiliary Gutters and Metallic Wireway) respectively. U.L. listing of lengths without listing connectors or fittings is not acceptable. Square D "Square-Duct", or approved equal.

2.04 SURFACE RACEWAYS

A. Surface raceway shall be a non-metallic two-piece design with a base and a snap-on removable cover with full line of fittings available including, but not limited to, flat, internal and external elbows, couplings, wire clips, blank end fittings, and a full compliment of device mounting brackets and plates. The fittings shall be colored to match the raceway and have the same conductor fill rating as the raceway.
    1. If the raceway will contain both low-voltage and power wiring systems, the base shall be dividable by means of a removable barrier section into different compartments. A cutting tool shall be available for the base and cover to ensure clean, square cuts.
    2. Device brackets shall be available to install single or two-gang devices either horizontal or vertical within the raceway. Devices for both power and data/communication shall have the capacity of mounting flush or in conjunction with faceplates. Device brackets and plates shall be colored to match the raceway.
    3. Surface non-metallic raceways and associated fittings that are UL listed, installed in dry interior locations, and installed in accordance with NEC Article 388 shall be used where specified on drawings. The base and cover shall be of rigid PVC material, meet UL 94, V-0 flammability standards, and meet UL 5A impact resistance standards.
B. Surface raceway finish: ivory.

2.05 INTERIOR OUTLET AND JUNCTION BOXES

A. Outlet and junction boxes in dry interior locations shall be as follows:
    1. For devices recessed within a vapor barrier wall (i.e. typical exterior wall) provide vapor barrier boxes, with gasketing as required to maintain the continuous vapor barrier. Exterior surfaces of boxes shall be sealed. Secure vapor retarder to box and provide flat blocking if required. Raceways entering/leaving boxes shall be sealed.
    2. For other interior locations provide minimum 4” square galvanized steel box.
B. General requirements:
    1. For flush installations provide appropriate tile or plaster covers.
    2. Boxes in walls and ceiling tiles shall be securely fastened in such a manner as not to rely on cover trim plate for support.
    3. Where surface mounted outside or in wet locations, boxes shall be iron alloy type, FS or FD with threaded hubs.

2.06 CABINETS

A. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
B. Hinged door in front cover with flush latch and concealed hinge.
C. Key latch to match panelboards.
D. Metal barriers to separate wiring of different systems and voltage.
E. Accessory feet where required for freestanding equipment.

2.07 HANDHOLES AND BOXES FOR EXTERIOR AND UNDERGROUND WIRING

A. Outdoor/Underground junction boxes or handholes shall be code sized cast iron or fiberglass reinforced concrete such as Armorcast A600 Series. Hardware shall be stainless steel and covers shall be permanently imprinted “ELECTRIC.”

B. Handholes shall meet the following ANSI 77 Tier loading requirements:
   1. Tier 22: Pedestrian, sidewalk, driveway, parking lot and off-roadway applications subject to non-deliberate heavy vehicular traffic.
   2. AASHTO H-20: Deliberate vehicular traffic applications.

PART 3 EXECUTION

3.01 GENERAL INFORMATION

A. Raceways and boxes shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

3.02 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit.
   2. Concealed Conduit, Aboveground: Rigid steel conduit; IMC; EMT; RNC, Type EPC-40-PVC.
   3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
   5. Underground Conduit:
      a. Under driveways, roadways, parking lots, etc: RNC, Type EPC- 80-PVC, direct buried.
      b. All other underground applications: RNC, Type EPC- 40-PVC, direct buried.

B. Comply with the following indoor applications, unless otherwise indicated:
   1. Finished Areas:
      a. New construction: Concealed unless indicated otherwise.
      b. Existing areas: Conceal in wall using flex conduit unless surface mounting is indicated. Where
   2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   3. Exposed, Not Subject to Physical Damage: EMT.
   4. Exposed, Not Subject to Severe Physical Damage: EMT.
   5. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:
      a. Loading dock.
      b. Areas used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. In parking garages or other vehicular areas below 7’-0”.
   6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment):
      a. LFMC in damp or wet locations.
      b. FMC in other areas.
   8. Damp or Wet Locations: Rigid steel conduit or IMC in other areas.
   9. Pool Mechanical Room, Pools, Saunas, Spas:
      a. Not Subject to Physical Damage: Type EPC-80-PVC.
      b. Not Subject to Severe Physical Damage: Type EPC-80-PVC.
      c. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC
   10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

11. Underslab Conduits:
    a. Feeders are allowed to be routed under slab. Coordinate routing with other trades. Document routing on as-builts.
    b. Branch circuits and home runs are not allowed to be routed underslab except where conditions prohibit overhead routing (to floor boxes, island cabinetry, partial height walls, etc).

3.03 INSTALLATION OF CONDUIT

A. Installation shall be in accordance with the NEC and as shown on the drawings. Flattened, dented, deformed, or opened conduit is not permitted. If damaged during installation, damaged conduit shall be replaced with new undamaged material. Prevent foreign matter from entering raceways by using temporary closure protection. Test conduits with ball mandrel. Clear any conduit which rejects the ball and mandrel.

B. Minimum size homerun to panels and cabinets is 3/4 inch. From all flush panelboards, terminal cabinets, and control panels, stub three empty 3/4” conduits up and down into the suspended ceiling spaces. In areas without ceilings, stub out near the underside of adjacent floor slabs.

C. Minimum size conduit for mechanical equipment and architectural motors is 3/4” unless specifically noted otherwise on plans or schedules.

D. Maintain separate raceway for 480/277V and 208/120V cabling.

E. General Installation:
    1. Conceal raceways within finished walls, ceilings, and floors, unless otherwise noted.
    2. Assure that conduit installation does not encroach into the ceiling height headroom, walkways, or doorways. Align and run conduit parallel or perpendicular to the building lines and or adjacent piping. Install horizontal runs close to the ceiling or beams, and secure with conduit straps. Independently support all conduits. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts).
    3. Complete raceways installation before starting conductor installation.
    4. Support all trapezes and all above ground feeder conduits from the building structure. Parallel runs of six (6) or more conduits shall be supported from the building structure. Do not support conduit with wire, nylon ties, nor perforated pipe straps. Remove wire used for temporary supports. Do not attach conduit to ceiling support wires. Do not support raceways from mechanical ductwork or equipment, except where required to connect to the equipment.
    5. Run all conduit in areas with unfinished ceilings above bottom chord of joists.
    6. Do not run conduits in columns except to feed column mounted devices.
    7. Place conduits at least 12" away from all hot piping and surfaces including domestic hot water lines. Do not mount conduit on mechanical equipment except where necessary to connect electrical devices mounted on the equipment. Provide 18" of flexible conduit in all runs "bridging" vibration mountings.
    8. Do not run conduit on or directly in front of access doors, removable panels, equipment removal spaces, control devices or other spaces necessary for normal maintenance and repair of the equipment.
    9. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system. Cap or plug conduit ends during construction. Cap or plug ends of conduits that are to remain empty and make watertight. Clean and swab conduits prior to pulling in conductors.
    10. Uncoated metal conduits installed underground shall be protected by two coats of bituminous paint (Koppers Bitumastic #50 or equal) or by vinyl tape (3M Scotchrap #43 or equal).
    11. Seal all conduits penetrations of smoke or fire rated walls or floors with intumescent type fire barriers, 3M or equal. Seal all conduits where they pass through exterior walls and where they enter exterior fixtures. Seal all conduits where temperature differential between adjacent spaces is greater than 30 degrees Fahrenheit. Seal all conduits penetrating walls built to deck.
    12. Conduits shall be provided with expansion or expansion/deflection fittings where traversing building or structure joints. Additionally, straight exposed conduit runs in or on buildings or structures shall be provided with expansion fittings at 100’ intervals. When in concrete slab on grade, provide expansion fittings at slab expansion joints.
    13. Provide a dedicated conduit and feeder conductors for each motor unit on the load side of each VFD feeding the motor.

14. Raceways embedded in slabs: Install in middle third of the slab thickness where practical and leave at least 1 inch (25 mm) concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run conduit larger than 1-inch (25 mm) trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit is used, raceways must be converted to rigid steel conduit or IMC before rising above floor.

F. Raceways for Optical Fiber and Communications Cable: Install ferrous raceways, metallic, rigid or flexible, as follows:
   1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
   2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
   3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements. Provide brushed ends.

G. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures, (between junction box at ceiling and each light fixtures, daisy-chaining fixtures is not accepted) equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations, even if not subject to severe physical damage.

3.04 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   4. Unless otherwise noted on the plans / drawings, in underground conduit runs longer than 150’ or in conduits runs containing #6awg or larger, install PVC 80 conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

3.05 PENETRATIONS

A. Refer to specification 26 05 00 “Common Work Results for Electrical” for requirements related to penetrations, sleeves, sleeve seals and firestopping.

B. Roof Penetrations: Conduit penetrations directly through roof membrane are prohibited. Route conduits through equipment curb or provide roof penetration assembly per architectural details.

C. Where raceways penetrate building envelopes: Flex shall not be used to penetrate vapor retarder. Seal joints (connectors and couplings) of raceway with vapor retarding tape, paint-on sealer, putty pads or other approved means. Provide solid blocking installed flat at all vapor retarder penetrations. Secure vapor retarder to blocking.

3.06 SURFACE RACEWAY

A. The raceway shall be securely supported at intervals in accordance with manufacturer’s installation sheets. All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer’s installation sheets. Coordinate installation with General Contractor where raceway is installed in or above casework.

B. Provide a separate ground conductor in each section of raceway and bond to supply conduit system in an approved manner.

3.07 WIREWAY

A. Installation shall be in accordance with the NEC Article 376, 378, and 366, respectively, and as shown on the drawings. Manufacturer's suggested insulating bushings and inserts at connections to outlets and corner fittings shall be used, as required.

3.08 INSTALLATION OF OUTLET BOXES

A. Installation shall be in accordance with the NEC Article 314 and as shown on schedules on the drawings.
   1. Interior outlet junction boxes in the same wall mounted back-to-back are prohibited. Junction boxes shall be securely mounted and arranged so that the boxes are square with the building surfaces.
   2. Wall outlet boxes shall be plumb and accurately aligned in rows. Mount ceiling boxes symmetrical with walls, beams and/or tiles.
   3. Mount outlet boxes in exposed masonry walls with the top or bottom of the box aligned with mortar joints, but not less than 15" A.F.F.
   4. Provide center mounted fixture studs in boxes for direct fixture mounting. Provide special fixture hangers and/or auxiliary supports where the weight of the fixture requires more support than the fixture stud.
   5. Where the weight of the devices and/or use of the finished outlet assembly requires additional support in ceiling tile installations, provide special hangers and/or auxiliary supports.
   6. Thru-wall boxes shall not be used unless specifically noted.
   7. Close openings in all outlet boxes during plaster and concrete work with plain paper or slip on plastic or metal plates. Do not use newspaper.
   8. Provide pull boxes fabricated of code gauge, galvanized sheet steel with screw covers held in place by corrosion resistant screws, and located to be accessible when the building is finished. Do not locate pull boxes in finished spaces without the specific approval of the Engineer/Architect. Equip boxes requiring 4 1/2" square or smaller covers with blank covers to match switch plates. Paint 5" square or larger steel pull box covers to match electrical panel fronts.
   9. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
   10. Set metal floor boxes level and flush with finished floor surface.
   11. Recess all device boxes in finished floors, ceilings, and walls unless otherwise indicated.

3.09 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line..

E. The tops of flush mounted ground boxes outdoor / underground shall be set at finished grade. After inspection and approval by the Engineer, fill with a re-enterable non-hygroscopic material such as Dri-Therm (Tel. 800-343-4188) powder and securely install covers.

3.10 PROTECTION / CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

B. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion. Remove all construction debris.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 36
CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections and Division 27 Specification Sections, apply to this Section.

1.02 SCOPE

A. This Section includes the furnishing, installation, and connection of cable tray for the support of low-voltage cabling.

B. Related Sections:

1. Sections 27 05 00 Common Work Results for Communications.

1.03 SUBMITTALS

A. Shop Drawings shall be submitted for approval for equipment as follows:

1. Ladder Cable Tray and associated fittings.
2. Wire Basket Cable Tray and associated fittings.

B. Samples of any or all proposed equipment or system components shall be submitted for examination/approval as requested.

C. Coordination Drawings: Submit drawings including floor plans and sections drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

D. Record Drawings. The Contractor shall keep layout plans on the job site, marking all changes made during installation. A set of As-Built / Record drawings shall be submitted.

E. Comply with submittal requirements in Section 27 05 00, Common Work Results for Communications.

1.04 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):

1. ANSI/NEMA VE1 – Metal Cable Tray Systems.
2. ANSI/NEMA VE2 – Metal Cable Tray Installation Guidelines.
3. UL.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 CABLE TRAY GENERAL GUIDELINES

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Acceptable Manufacturers: Basor, Cable-MGR, Cablofil, Cope
2. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Cable Tray that is UL listed, manufactured in accordance with NEMA VE1, and installed in accordance with NEC Article 392 shall be used. Tray sizes shall have 4" minimum usable load depth, or as noted on the drawing. Trapeze hangers and center-hung supports shall be supported by 1/2" (minimum) diameter rods for ladder and 3/8" (minimum) diameter rods for wire basket. Special accessories shall be furnished as required to protect, support, and install a complete cable tray system. Accessories shall consist of, but are not limited to, section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, grounding/bonding connections/lugs, etc.

2.03 STANDARD LADDER STYLE CABLE TRAY

A. Description.

1. Configuration: 12-inch wide UL Classified Universal Cable Runway, manufactured from 3/8-inch wide by 1-1/2-inch high tubular steel with 0.065-inch wall thickness. Two I-beam side rails with transverse rungs welded to side rails.
2. Powder Coated Black or Grey in color
3. Rung Spacing: 9 inches (225 mm) on center.
4. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
5. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
6. No portion of the rungs shall protrude below the bottom plane of the side rails.
7. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
8. Minimum Usable Load Depth: 4 inches.
9. Straight Section Lengths: 10 feet except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
10. Width: Tray widths shall be as shown on drawings.
11. Fitting Minimum Radius: 24” (300 mm).
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
    a. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms.
    b. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray:

B. Splice plates:

1. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum cable tray will be used outdoors, then hardware shall be Type 316 stainless.
2. Steel Tray (including pre-galvanized and hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A607, Grade 50. Each splice plate shall be attached with four ribbed neck carriage bolts with serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.

2.04 WIRE BASKET STYLE CABLE TRAY

A. Description

1. Configuration: Wires are formed into a standard 2”x4” wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
2. Material: Wire basket runway shall be made of ASTM A510 high strength steel wires with no bends.
3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:
    a. Straight sections shall be furnished in standard 118-inch lengths.
    b. Wire-Basket Depth: 2, 4, 6, inch depth by 12 inches, 16 inches, 18 inches, 20 inches or 24 inches, wide. Wire basket sizes shall be as shown on the plans.
5. All fittings shall be field formed as needed. All splicing assemblies shall be the bolted type using serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 Stainless Steel. Special accessories shall be furnished as required to protect, support, and install a wire basket runway system. If the raceway will contain both low-voltage and power wiring systems, the base shall be dividable by means of a removable barrier section into different compartments. A cutting tool shall be available for the base and cover to ensure clean, square cuts. The raceway, associated fittings, and devices shall be installed according the manufacturer’s instructions.

2.05 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

PART 3 EXECUTION

3.01 GENERAL INFORMATION

A. Good workmanship shall be evidenced in the installation of all cable tray. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1, most recent addition, is hereby adopted to define such workmanship and the installation of conductors and cables.

3.02 COORDINATION

A. Coordinate layout and installation of wire mesh cable tray with other installations; including: architectural soffits, ductwork, ceiling grid, sprinkler, piping, etc.
   1. Revise locations and elevations from those indicated as required to suite field conditions and as approved by Architect/Engineer.

3.03 INSTALLATION OF CABLE TRAY

A. Installation shall be in accordance with equipment manufacturer's instructions, and with recommendations in NEMA VE 2 and NEC. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, crosses and grounding.
   1. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment
   2. Remove burrs and sharp edges from cable trays.
   3. Fasten cable tray supports to building structure.
   4. Place supports so that spans do not exceed maximum spans on schedules. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
   5. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
   6. Do not install more than one cable tray splice between supports
   7. Support bus assembly to prevent twisting from eccentric loading.
   8. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
   9. Make connections to equipment, as required, with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.
   10. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 1. Space connectors and set gaps according to applicable standard.
   11. Make changes in direction and elevation using standard fittings.
   12. Make cable tray connections using standard fittings.
   13. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
   14. If cable trays are sized for future cables, specify provisions for penetrations with sleeves through fire-rated partitions or use "repairable" firestop-sealing material. Include specific firestopping requirements of this Section in a schedule developed in the Division 07 Section referenced in paragraph above.
   15. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
   16. Workspace: Install cable trays with enough space to permit access for installing cables. Install bottom of tray 4” above lay-in ceiling with minimum of 6” clearance on sides and 12” clearance above.
   17. Install tray so it does not interfere with lay-in panel removal, “lift-out”.
   18. Coordinate actual routing of cable tray with other trades.

B. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

C. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.04 INSTALLATION OF CABLE IN CABLE TRAY

A. Install cables only when cable tray installation has been completed and inspected.

1. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
2. On vertical runs, fasten cables to tray every 18 inches (457 mm). Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
3. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
4. In existing construction, remove inactive or dead cables from cable tray.
5. Install covers, if required, after installation of cable is completed.

3.05 GROUNDING / BONDING CONNECTIONS

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

F. Provide bare copper grounding / bonding conductor, minimum of #6awg, along cable tray installation at all joints or per listed manufacturer supplied identified grounding means (NEC 392.7).

G. Provide bare copper grounding / bonding conductor jumpers to supplying conduit stubs.

3.06 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
6. Check for improperly sized or installed bonding jumpers.
7. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.
9. Report results in writing.

3.07 PROTECTION

A. Protect installed cable trays.

1. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 05 36

SECTION 26 05 53
IDENTIFICATION FOR ELEC SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installation of identification of electrical equipment as specified and indicated on the drawings.

1.02 SUBMITTALS

A. Samples of each type of proposed label and/or signs shall be submitted for examination/approval as requested.

B. Record Drawings. The Contractor shall keep layout plans on the job site, marking all changes made during installation. A set of As-Built / Record drawings shall be submitted.

1.03 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. ANSI A13.1 – Pipe Identification Standard.
   2. 29 CFR 1910.145 – Accident Prevention Tags.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 IDENTIFICATION LABELS / NAMEPLATES

A. Provide equipment identification labels per labels identified on drawings. Nameplates: Engraved three-layer laminated plastic with white melamine core and black melamine surface:
   1. Engrave characters with a minimum height of 1/4".
   2. Punched or drilled for screw mounting.
   3. Provide white letters on a black background for equipment on normal utility power system.
   4. Provide white letters on a red background for equipment on emergency or standby power system.

B. Concealed Indelible ink ('Sharpie') / Adhesive Marking Labels for Raceways and Cable: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Emergency, Lighting, Power, Communications, Control, Fire Alarm). Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
   1. Label Size:
      a. Raceways 1-Inch and Smaller: 1-1/8 inches high by 4 inches long.
      b. Raceways Larger than 1-Inch: 1-1/8 inches high by 8 inches long.
   2. Color: Black legend on orange background.
   3. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

C. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Raceway and Cable Identification: Flexible acrylic bands sized to suit the raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the raceway or cable.

2.03 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Provide communication and control-cable identification with one of the following methods:
   1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
   2. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
   3. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
   4. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), 19 gauge, with stamped legend, punched for use with self-locking nylon tie fastener.

5. Where exposed to damage or rough service provide one of the following two methods.
    a. Write-On Tags: Polyester tag, .015" thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
    b. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.04 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
    1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
    2. Compounded for permanent direct-burial service.
    3. Embedded continuous metallic strip or core.
    4. Printed legend shall indicate type of underground line.

2.05 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.
B. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/8-inch minimum thick. Engraved legend in white letters on black face and punched for mechanical fasteners.
C. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).
D. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).
E. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.06 INSTRUCTION SIGNS

A. Provide instructions signs as indicated on drawings:
    1. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
    2. Engraved legend with black letters on white face.
    3. Punched or drilled for mechanical fasteners.
    4. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.07 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
    1. Minimum Width: 3/16 inch (5 mm).
    2. Tensile Strength: 50 lb (22.6 kg), minimum.
    3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
    4. Color: Black, except where used for color-coding.
B. Panelboard and relay schedules shall be typed and dated on card stock.
C. Striped Hazard Tape. 3" min width, anti-slip contrasting yellow and black tape installed on floor to delineate working clearances of panels, switchboards, etc.

PART 3 EXECUTION

3.01 GENERAL INFORMATION

A. Identification means shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

3.02 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation, Maintenance and Warranty Data Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
    1. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

2. Coordinate installation of identifying devices with location of access panels and doors.
3. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 INSTALLATION OF IDENTIFICATION / LABEL NAMEPLATES

A. Degrease and clean surfaces to receive nameplates. Install nameplates parallel to equipment lines. Secure nameplates to equipment fronts using screws, rivets, or adhesive. Secure nameplate to dead-front barrier recessed panelboards in finished locations. Embossed tape will not be permitted for any application.

B. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation, Maintenance and Warranty Data Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Self-adhesive, engraved, melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
2. Nameplate Engraving
   a. Provide nameplates to identify all electrical distribution and control equipment, and loads served.
   b. Letter Height: 1/8 inch for individual switches and loads served, 1/4 inch for distribution and control equipment identification.
   c. Switchboards, panelboards, nameplates shall include: equipment name, the equipment name where the source originates, and equipment voltage.
3. Box Identification:
   a. Label box cover with the panelboard(s) name and circuit numbers contained within. Use marking pen to label all feeder junction and pull boxes; communications systems junction and pull boxes; all junction boxes, pull boxes, and raceways installed for future use.
   b. Paint covers of systems' junction boxes with assigned paint color and label with marking pen.
4. Equipment Identification:
   a. Provide plastic laminated "NAME PLATES" as indicated or required in individual specification sections.
   b. Install name plates inside covers in finished areas using approved contact cement.
   c. Install name plates outside covers in unfinished areas using approved contact cement, self-tapping screws, or rivets.
   d. Provide engraved cover plates where indicated on the Drawings.
5. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.
6. Device Labeling:
   a. Identify panelboard and circuit number from which served. Use permanent ink marker to label inside of box, and provide permanent adhesive labels (clear tape with black lettering) on front of coverplate. Install label on interior of device coverplate for weatherproof locations.
7. Final Owner Room Numbering: All labeling, identification or programming related to room numbering shall follow the Owner's final room numbering scheme. Obtain documentation of Owner's final room numbering prior to final labeling and/or programming. Identification of all systems shall utilize Owner's final room numbers.

3.04 INSTALLATION OF CABLE OR CONDUCTOR IDENTIFICATION / LABEL

A. Wire Identification:
   1. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
   2. Power-Circuit Feeder Conductor Identification: Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
   3. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, Identify each ungrounded conductor according to source and circuit number.
   4. Conductors to Be Extended in the Future: Attach label to conductors and list source and circuit number.
   5. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections with source and circuit/zone number.
   6. Match identification markings with designations used in panelboard / control panel shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

3.05 INSTALLATION OF UNDERGROUND-LINE WARNING TAPE

A. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. During backfilling of trenches, install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

B. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

C. Accessible Raceways More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches (50 mm) high, with snap-around labels. Repeat legend at 25-foot maximum intervals.

3.06 INSTALLATION OF WARNING LABELS AND SIGNS AND INSTRUCTIONS

A. Provide warning, caution, or instruction label and signs and /or stencils as follows:
   1. Install warning, caution, or instructions signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
   2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
   3. Install striped hazard tape to indicate working space of panelboards, switchboards, etc. when equipment is not located in a dedicated electrical room. For example mechanical rooms, kitchens, receiving area and hallways.

3.07 IDENTIFICATION SCHEME

A. Verify system identification scheme / color coding with owner. If identification scheme is not defined the following color code shall be used:
   1. Fire Alarm System: Red.
   2. Normal Electrical Distribution System: Silver (unpainted).
   3. Essential Electrical System: Green.
   4. Security and Nurse Call System: Purple.
   5. Telecommunication System: Blue.

3.08 EQUIPMENT LABELS

A. Equipment to Be Labeled:
   1. Panelboards, relay panels, electrical cabinets, and enclosures.
   2. Access doors and panels for concealed electrical items.
   3. Electrical switchgear and switchboards.
   4. Emergency system boxes and enclosures.
   5. Disconnect switches.
   6. Enclosed circuit breakers.
   7. Motor starters.
   8. Push-button stations / HVAC equipment control stations.
   9. Power transfer equipment.
   10. Contactors.
   11. Remote-controlled switches, dimmer modules, and control devices.
   12. Battery inverter units.
   13. Battery racks.
   14. Power-generating units.
   15. Voice and data cable terminal equipment.
   16. Master clock and program equipment.
   17. Intercommunication and call system master and staff stations.
   18. Television/audio components, racks, and controls.
   19. Fire-alarm control panel, NAC panel, and annunciators.
   20. Fire alarm devices associated with controlling AHU / mechanical equipment.
   21. Fire alarm door release button.
   22. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
   23. Monitoring and control equipment.
   24. Uninterruptible power supply equipment.
   25. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

END OF SECTION 26 05 53

SECTION 26 05 73
OVERCURRENT PROTECTIVE DEVICE COORD STUDY

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes computer-based, fault-current, overcurrent protective device coordination, and arc flash studies.
   1. Protective devices shall be set based on results of the protective device coordination study.
   2. Equipment shall be labeled based on results of arc flash study.

B. Study shall include field verification of existing conditions and equipment, as well as new equipment. Refer to riser/one-line diagram for scope of equipment to be studied.

C. Life safety branch and elevators to be selectively coordinated to 0.01 seconds. Normal, critical and equipment branch to be coordinated to 0.1 seconds. Coordinate all breaker and panel requirements due to coordination study with manufacturer prior to ordering. Owner shall not be responsible for any extra cost required by the coordination study.

1.02 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals: The following submittals shall be made at the same time with the submittal for approval for system protective devices.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.
   4. Study shall include the following sections:
      a. Executive Summary.
      b. Descriptions, purpose, basis and scope of the study.
      c. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
      d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
      e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
      f. Details of the incident energy and flash protection boundary calculations.
      g. Recommendations for system improvements, where conflicts occur.
      h. One-line diagram.

E. Submit final report in hard copy format and electronic format (PDF and SKM file).

1.03 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Provide products by the following:
   1. SKM Systems Analysis, Inc.

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted at the same time with the coordination study may not be installed.

3.02 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.
   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
      c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
      d. Generator thermal-damage curve.
      e. Ratings, types, and settings of utility company's overcurrent protective devices.
      f. Special overcurrent protective device settings or types stipulated by utility company.
      g. Time-current-characteristic curves of devices indicated to be coordinated.
      h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

5. Present and future motors and generators.
6. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

3.03 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
1. Switchgear and switchboard bus.
2. Medium-voltage controller.
3. Motor-control center.
4. Distribution panelboard.
5. Branch circuit panelboard.
6. Generator.
7. Automatic Transfer Switches.
8. Other major electrical equipment.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 242.
1. Transformers:
a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.
2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.04 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.
C. Transformer Primary Overcurrent Protective Devices:
    1. Device shall not operate in response to the following:
        a. Inrush current when first energized.
        b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
        c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
    2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
    1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
        a. Device tag.
        b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
        c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
        d. Fuse-current rating and type.
        e. Ground-fault relay-pickup and time-delay settings.
    2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
        a. Device tag.
        b. Voltage and current ratio for curves.
        c. Three-phase and single-phase damage points for each transformer.
        d. No damage, melting, and clearing curves for fuses.
        e. Cable damage curves.
        f. Transformer inrush points.
        g. Maximum fault-current cutoff point.
F. Completed data sheets for setting of overcurrent protective devices.

3.05 ARC FLASH STUDY

A. Calculate available arc flash incident energy and determine personal protective equipment (PPE) requirements for each equipment.
B. Provide labels for installation at each equipment.
    1. Provide a minimum 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
    2. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
    3. The label shall include the following information, at a minimum:
        a. Arc hazard boundary (inches).
        b. Working distance (inches).
        c. Arc flash incident energy at the working distance (calories/ cm2).
        d. PPE category and description including the glove rating.
        e. Voltage rating of the equipment.
        f. Limited approach distance (inches).

g. Restricted approach distance (inches).
h. Prohibited approach distance (inches).
i. Equipment/bus designation.
j. Date prepared.
k. Engineering company, report number, revision number.

4. Labels shall be machine printed, with no field markings.

3.06 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended provided by the coordination study.

B. Make modifications to equipment as required to accomplish conformance circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

END OF SECTION 26 05 73

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes requirements for commissioning the Electrical systems and its subsystems and equipment in accordance with the Minnesota Energy Code. This Section supplements the general requirements specified in Division 01.

B. The systems to be commissioned include:
   1. Lighting Control System
   2. Power Distribution System
   3. Essential Power Distribution System which includes:
      a. Generator
      b. Portable Generator Docking Station
      c. Emergency Switchboards and Panelboards
      d. Transfer Switches

1.02 DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. BoD: Basis of Design.

C. Cx: Commissioning.

D. CA: Commissioning Authority.

E. CM: Construction Manager

F. DID: Design Intent Document

G. GC: General Contractor

H. PM: Owners Project Manager, or representative.

I. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

J. TAB: Testing, Adjusting, and Balancing.

K. TCC: Temperature Control Contractor.

L. EC: Electrical Contractor

1.03 CONTRACTOR'S RESPONSIBILITIES

A. GC/CM Coordinator: The GC/CM shall assign a qualified individual to function as the coordinator for commissioning activities. The coordinator shall have a minimum of 5 years experience in construction management. The coordinators responsibilities shall include but not be limited to the following:
   1. Coordinating meetings between the CA and construction team
   2. Scheduling of Cx activities.
   3. Coordination of O&M deliverables to CA
   4. Coordination of O&M training.
   5. Coordination of corrective action generated from Cx events.
   6. Assist the CA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.

B. Electrical contractor responsibilities: Each subcontractor shall assign a contact responsible for communications between the subcontractor and the GC/CM commissioning coordinator. The subcontractor's contact person's responsibilities shall include, but not be limited to the following:
   1. Communication with the GC/CM's commissioning coordinator.
   2. Coordinating meetings between the CA and construction team.
   3. Scheduling of Cx activities.
   4. Submittal of contractor tests.
   5. Submittal of Pre-functional checklist.
   6. Review of functional test procedures developed by CA

7. Participating in functional tests
8. Completing corrective action work
9. Assembly of O&M manuals
10. Providing specified training.
11. Assist the CA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.

C. Lighting Control Contractor:
1. With the CA and design professional, review control designs for compliance with the Contract Documents, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.

D. Electrical and Mechanical Contractors
1. The Electrical and Mechanical Contractors shall coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.

1.04 EQUIPMENT SUPPLIERS

A. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
B. Assist in equipment testing per agreements with Subcontractors.
C. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data- logging equipment that may be used by the CA.
D. Through the contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope and budget.
E. Provide information requested by CA regarding equipment sequence of operation and testing procedures.
F. Review test procedures for equipment installed by factory representatives.

1.05 EQUIPMENT SUBMITTALS

A. The CA will identify those submittals to be delivered to the CA, following approval by the design professionals.
B. Submit copies of the above selected shop drawings to the CA, concurrent with submittals to the design professionals.

1.06 CONSTRUCTION PHASE DOCUMENTATION

A. Submit to the CA copies of Requests for Information (RFI), Architects Supplemental Instructions (ASI), and Change Orders (CO).

1.07 CONTRACTOR TESTING

A. Subcontractors shall forward, through the GC/CM, a schedule of specified contractor tests, which include the following:
1. Section 26 09 23 and 26 09 43: Lighting Controls and Network Lighting Controls.
a. Test, calibrate, and set all digital and analog sensing and actuating devices.
b. Check each control point by making a comparison between the control command at the panel and the status of the controlled device.
c. Test the operation of the lighting controls and integral components to verify they respond appropriately to changing conditions and parameters as specified.
d. Validate all interfaces with other systems on a point by point basis.
2. Section 26 24 13, Section 26 24 16, 26 32 13, 26 36 00 and 26 36 50: Switchboards, Panelboards, Engine Generators, Portable Generator Docking Station and Transfer Switches
a. Verify components are installed and programmed correctly to accomplish intent of essential electrical power system.
b. Assist in implementing an integrated test to ensure emergency components operate as intended during utility power failure, on-site power generation and utility power restoration.
c. Verify breakers in all essential power distribution equipment are set per coordination study.
d. Verify portable docking station are installed and functioning properly.

B. The schedule shall allow at least 1 weeks notice to the CA. The CA reserves the right to witness and document all specified tests.
C. Submit contractors test reports/results to the appropriate design professionals, as specified, and concurrently to the CA upon successful completion of each test.
D. The Contractor responsible for the system or component being tested shall be responsible to provide all test equipment necessary to fulfill the testing requirements of this Division.

1.08 PRE-FUNCTIONAL SYSTEM CHECKOUT

A. Subcontractors shall forward, through the GC/CM, all completed pre-functional checkout forms to the CA at least 1 week prior to the scheduled start of functional testing. These tests shall be signed off by the appropriate contractors indicating systems are ready for testing.
    1. Included the following with the pre-functional checklists:
        a. Copies of the manufacturers written start-up procedures that have been signed off by the installing contractor.
        b. The manufacturers normally used field check out sheets.
B. Functional testing will not commence until the above checklists have been documented as completed and is ready for functional testing.

1.09 SENSOR CALIBRATION

A. Perform sensor calibration, or provide documentation verifying manufacturer's performance of calibration for all sensors utilized in the Cx process.
B. A sensor is defined as any device which measures a system parameter for control purposes or for monitoring the system performance.
C. The CA reserves the right to observe on site calibration procedures.

1.10 FUNCTIONAL TESTS

A. Sample functional test procedures are included in PART 3 of this specification section. These forms are included to communicate the level of detail involved in the commissioning testing process.
B. Contractors shall review, comment and sign off on the functional test procedures developed by the CA. Provide feedback as to the efficiency of the procedures. Review for safety and operating issues. Submit, if appropriate, alternate approaches to achieving the same results.
C. Contractors shall assist in the development of scheduling commissioning events and tasks into the master construction schedule.
D. Submit the functional testing schedule to the CA at least four (4) weeks prior to the commencement of testing.
E. Contractors conducting the functional tests shall provide all personnel and equipment necessary for conducting the tests.

1.11 CORRECTIVE ACTIONS

A. Problem solving: The CA may recommend solutions to problems found; however the burden of responsibility to solve, correct and retest problems is with the GC/CM, subcontractors, and the design professionals.
B. Corrective action procedures:
    1. The CA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the GC/CM on a corrective issues log generated by the CA.
    2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CA. In such cases the deficiency and resolution will be documented on the procedure form.
    3. As tests progress and a deficiency are identified, the CA discusses the issue with the executing contractor.
        a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
            1) The CA documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CA submits the non-compliance reports to then GC/CM for signature. A copy is provided to the Sub and CA. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CA.
            2) The CA reschedules the test and the test is repeated.

b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
   1) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the GC/CM and to the Sub representative assumed to be responsible.
   2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
   3) The CA documents the resolution process.
   4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CA. The CA reschedules the test and the test is repeated until satisfactory performance is achieved.

4. Cost of Retesting.
   a. The cost for the Sub to retest a pre-functional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC/CM.
   b. For a deficiency identified, not related to any pre-functional checklist or start-up fault, the following shall apply: The CA will direct the retesting of the equipment once at no "charge" to the GC/CM for their time. However, the CA's time for a second retest will be charged to the GC/CM, who may choose to recover costs from the responsible Sub.
   c. The time for the CA to direct any retesting required because a specific pre-functional checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to the GC/CM, who may choose to recover costs from the party responsible for executing the faulty pre-functional test.
5. The Contractor shall respond in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
6. The CA retains the original corrective issues log until the end of the project.
7. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.

1.12 COMMISSIONING DOCUMENTATION

A. The following list summarizes the documentation submittals required of the contractors, to the CA.
   1. Schedule of contractors' tests
   2. Contractor test reports.
   3. Final test and balance report
   4. System checkout schedule.
   5. Sensor calibration documentation.
   6. Pre-functional checklists
   7. Functional testing schedule.
   8. Corrective action documentation.
   9. Operation and maintenance manuals.
   10. Operation and maintenance training agenda and schedule.

1.13 OPERATION AND MAINTENANCE MANUALS

A. Submit operation and maintenance manuals for systems being commissioned to the design professionals, and the CA for review and approval. Submittal will be at least 90 days prior to verification testing, or earlier.
B. The operation and maintenance manuals will meet the requirements of Section 01770, "Closeout Procedures" and the individual technical sections covered by each O&M manual.

1.14 TRAINING OF OWNER PERSONNEL

A. The training shall meet the requirements of the General Requirements Sections and the individual technical sections covered by each system requiring training.
B. Coordinate training of Owner personnel through the CA.

C. Provide training for systems and components for systems to be commissioned.
   1. Submit a training session plan to the CA for approval no later than four (4) weeks prior to the training date.
   2. Utilize the "Training and Orientation Agenda" form (See Part 3 of this specification section) to submit a session plan. The training session plan shall include the following components:
      a. Equipment
      b. Trainer's name and company affiliation
      c. Agenda
      d. Time required for training agenda
      e. Training procedures to be utilized.
   3. Document completion of training by completing the "Staff Training and Orientation Record" form (See Part 3 of this specification section). Indicate on the form:
      a. Date of training
      b. Topics covered
      c. List of Attendees/affiliation
      d. Hours of training
      e. Signoff/acceptance from the CA.

1.15 DEFERRED TESTING

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the PM. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CA shall coordinate this activity through the CA. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CA witnessing.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Division contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical system and controls system in Division 26 Two-way radios shall be provided by the Division Contractor conducting the test requiring the radios.

B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone datalogging equipment that may be used by the CA.

C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5□F and a resolution of + or - 0.1□F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily avail- able.

PART 3 EXECUTION

3.01 COMMISSIONING DOCUMENTATION FORMS

A. The following pages are samples of forms to be utilized in the commissioning process. The actual test procedures will be issued during the construction phase.

END OF SECTION 26 08 00

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installing of all labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes, and equipment necessary for and incidental to the delivery, installation, and furnishing of lighting control devices as described herein. Unidentified devices shall be the same types as those provided in similar areas.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for approval for all lighting control devices as follows:
   1. Line-voltage light switches.
   2. Low-voltage light switches.
   3. Wall-box dimmers.
   4. Occupancy sensors.
   5. Photoelectric switches.
   6. Outdoor motion sensors.
   7. Emergency shunt relays.

B. While “typical” connections and circuits are of interest, complete system Shop Drawings shall be prepared for this particular project that include device layout, orientation, point-to-point wiring diagram(s), and conductor sizes and types.
   1. Submit any interconnection diagrams to the lighting control panel showing proper wiring.
   2. Submit lighting plan showing location, orientation, and coverage area of each sensor.

C. Samples of any or all proposed equipment or system components shall be submitted for examination/approval as requested.

D. Record Drawings. The Contractor shall keep layout plans on the job site, marking all changes made during installation. A set of As-Built / Record drawings shall be submitted.

E. Final Documentation. Submit all operation, maintenance and warranty data manuals showing test results.

1.03 QUALITY ASSURANCE

A. The equipment manufacturer shall be regularly engaged in manufacture of lighting control devices, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than ten years.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory’s label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 LINE VOLTAGE LIGHT SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Industrial Grade Toggle Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
      b. Hubbell; 1221 (single pole), 1222 (two pole), 1223 (three way), 1224 (four way).
      c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
      d. Pass & Seymour; Spec grade 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
      e. See plan for keyed switch, pilot options.

C. Refer to drawings for key-switches when required.

D. Refer to 26 27 26 Wiring Devices for device finish information.

2.03 LOW VOLTAGE LIGHTING CONTROL SYSTEMS

A. System Description:
   1. Provide complete lighting control system as described herein and on the drawings. Plans are schematic and show intent (switching locations/quantities, sensor locations/quantities, control zones, dimming requirements, manual/automatic requirements, normal/emergency requirements, etc.). Ancillary parts such as room controllers, power packs, device managers, cabling, etc. are not shown on plans and shall be included in the contractor's bid.
   2. Wireless controls are prohibited unless explicitly noted.

B. Products: Subject to compliance with requirements, provide one of the following manufacturers:
   1. Current
   2. Leviton Mfg. Company Inc.
   3. nLight; Acuity Lighting Group, Inc.
   4. Sensor Switch, Inc.
   5. Watt Stopper (The).

2.04 LOW VOLTAGE SWITCHES

A. Product Description:
   1. Low voltage decorator-style push-button switch separate single or dual on/off buttons in one gang. Provide three-way switching, dimming, and wall sensors where indicated on plans.
   2. Dimming switches: 0-10V decorator-style push-button switch with combined on/off button and separate up/down buttons on single gang. Engraving as required to match lighting details on plans.

B. Refer to 26 27 26 Wiring Devices for device finish information.

C. Connect to occupancy sensor(s) as indicated on plans and program as indicated on schedule found on plans. Programming is generally as follows:
   1. Typical applications (offices, classrooms, etc.): Manual-on, auto-off configuration.
   2. Toilets, maintenance closets, storage, etc.: Auto-on, auto-off configuration.

2.05 OCCUPANCY SENSORS

A. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit:
   1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time-delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   3. Relay Unit / Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70. Unit shall Have low-voltage Teflon coated leads rated for plenum locations.
   4. Mounting:
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
   6. Bypass Switch: Override the on function in case of sensor failure.
   7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
   8. High immunity to false triggering by RFI and EMI
   9. Separate 24 VAC dry contacts for EMCS connections.
   10. Have no leakage current to load, in manual or in Auto/Off mode, and have voltage drop protection.

B. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage:
   1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
   2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

C. Ultrasonic Type / Microphonic: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage:
   1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
   2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit:
   1. Sensitivity Adjustment: Separate for each sensing technology.
   2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
   3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.06 PHOTOELECTRIC SWITCHES

A. Interior Switches:
   1. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
      a. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
      b. Relay Unit: Dry contacts rated for 20A ballast load at 120- and 277-V ac, for 13A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
      c. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
      d. Time-Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
      e. Indicator: Two LEDs to indicate the beginning of on-off cycles.
   2. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit (mounted on luminaire), to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
      a. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.

b. Relay Unit: Dry contacts rated for 20A ballast load at 120- and 277-V ac, for 13A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
c. Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lx), with an adjustment for turn-on and turn-off levels within that range.
d. Time-Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
e. Indicator: Two LEDs to indicate the beginning of on-off cycles.

B. Exterior Switches:
1. Description: Solid-state, with DPST dry contacts rated for 1800-VA tungsten, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
b. Time Delay: 15-second minimum, to prevent false operation.
c. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
d. Mounting: Twist-lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.07 OUTDOOR MOTION SENSORS

A. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as raintight according to UL 773A:
1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:
a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc (11 to 215 lx); keep lighting off during daylight hours.

B. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).

C. Detection Coverage: Up to 35 feet (11 m), with a field of view of 180 degrees.

D. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

E. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
2. Indicator: LED, to show when motion is being detected during testing and normal operation of the

2.08 EMERGENCY SHUNT RELAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lighting Control and Design, Inc.
2. Bodine GTD20A.
3. Lutron Equal.
4. Or equal.

B. Description: Normally closed, electrically held relay, to automatically transfer from normal power circuit supply to the emergency power circuit supply and arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924. Verify all wiring contacts and connection requirements with manufacturer.

2.09 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.01 GENERAL INFORMATION

A. Lighting control devices shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. System installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work. All wiring and devices shall be installed in accordance with manufacturer’s and UL recommendations. Class II low-voltage occupancy sensor wiring in exposed areas shall be installed in metallic raceway. Class II low-voltage occupancy sensor wiring in concealed accessible areas that is not installed in conduit shall be plenum rated. All system junction boxes must be clearly marked for easy identification.

C. Wiring splices shall be avoided and, if needed, must be made only in junction boxes. All conductors shall be labeled on each end with “E-Z markers,” or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc., shall be clearly labeled on the equipment panel.

3.02 PLANNING / COORDINATION

A. The Contractor shall arrange a pre-installation meeting with the lighting control device vendor(s), and an Owner’s representative at the Owner’s facility to verify placement of devices, installation criteria, and functionality.

3.03 OCCUPANCY SENSOR INSTALLATION

A. Installation Requirements:

1. Sensors shown on plan are diagrammatic only. Occupancy sensor vendor shall design actual layout of devices and submit for shop drawings for review.
    a. Rooms shall have 90% to 100% coverage of the designated controlled area to accommodate all occupancy habits of single or multiple occupants at any location with the room or area.
    b. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas which are to be provided with sensor protection.
    c. Ensure the best possible installation (placement and quantity) in the available space and coordinate with local difficulties due to space limitations or interference of structural components.
    d. Provide additional occupancy sensors in a room or space beyond that indicated if necessary to provide coverage required.
2. Locate and aim sensors for complete and proper volumetric coverage per manufacturer’s recommendations.
3. Coordinate with installation and programming of low-voltage switches.

3.04 LIGHT LEVEL SENSOR INSTALLATION

A. Install and aim sensors north if possible, never south. Install pointing away from artificial sources of light.

3.05 TIME-SWITCH INSTALLATION

A. Mount time switches with elastomeric isolator pads, to eliminate structure-borne vibration, unless time-switches are installed in an enclosure with factory-installed vibration isolators.

3.06 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.07 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
   1. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
   2. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
   3. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.08 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
   3. Label time-switches and contactors with a unique designation.

3.09 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including luminaires, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

3.10 FIELD QUALITY CONTROL

A. Field Wiring shall be checked and tested to ensure that there are no grounds, opens, or shorts. The minimum allowable resistance between any two conductors or between conductors and ground is 10 megohms after all conduit and conductors have been installed, but before the sensors are connected. Perform walk tests and set-up procedures for each sensor as specified by the manufacturer to ensure that all boundaries of coverage are sufficient.

B. The Manufacturer’s Representative shall submit a written test report that the system has been 100% tested, approved, and commissioned. The final test shall be witnessed by the Owner’s representative, Electrical Engineer, Electrical Contractor, and performed by the manufacturer’s representative. The final test report must be received and acknowledged by the Engineer prior to request for final payment. Perform all electrical and mechanical tests required by the equipment manufacturer. The installer shall prepare a checkout report and submit in triplicate, one copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:
   1. Indication that lighting control devices are properly located, adjusted, (time-delay confirmed, aimed and sensitivity level determined) and communicating with desired load equipment.
   2. Indication that lighting control devices are functioning as determined by the specifications and as decided at the pre-installation meeting.
   3. Identification and replacement of lighting control devices that failed tests.
   4. Tests of individual areas as applicable.
   5. Installer’s name and date.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.11 WARRANTY

A. The Contractor shall provide parts and labor warranty for the completed occupancy sensor system wiring, equipment, and software to be free from inherent mechanical and electrical defects for a period of one year from the date of completion and acceptance as issued by the Architect’s certificate of completion. The individual sensors shall have a five year warranty.

3.12 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for any lighting control systems specified elsewhere in Division 26 Sections.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training." The training shall familiarize the Owner’s personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems. Provide forms and schedules for organization and documentation of all system operating parameters.

3.13 RECORD DRAWING DOCUMENTATION

A. After successful completion of all the tests and adjustments listed above, the Contractor shall submit the following information to the Engineer in the Operation, Maintenance and Warranty Data Manuals:

1. Complete As-Built Wiring Diagrams.
2. System Operating Manuals.
3. Copy of the Test Report, as detailed above.

END OF SECTION 26 09 23

SECTION 26 09 43
NETWORK LIGHTING CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes intelligent low voltage lighting control system with relays and control module.
B. Network lighting controls are for exterior lighting only.
C. Wireless systems are not allowed.

1.02 SUBMITTALS

A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.
B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
   1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
   2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
   3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
D. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.
E. Field quality-control test reports.
F. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
G. Warranty: Special warranty specified in this Section.

1.03 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
D. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.
E. Comply with NFPA 70.

1.04 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.
   1. Match components and interconnections for optimum performance of lighting control functions.
   2. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of software input/output to execute switching or dimming commands.
      b. Failure of modular relays to operate under manual or software commands.
      c. Damage of electronic components due to transient voltage surges.
   2. Warranty Period: Two years from date of Substantial Completion.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Relays: Equal to 5% percent of amount installed for each size indicated, but no fewer than 2 relays.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
B. Douglas Lighting Control
   1. Leviton Mfg. Company Inc.
   2. Acuity nLight
   3. Wattstopper
   4. Current NX

2.02 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
B. Performance Requirements: Manual switch operation sends a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

2.03 RELAY PANEL WITH CONTROL MODULE

A. Backbox: Factory furnished for wall mounting. Must be capable of being shipped ahead of controller chassis to allow rough-in of electrical connections prior to controller installation.
B. Barrier Separations: Provide a mechanical barrier that separates all line voltage components and wiring from all control voltage components and wiring. An additional barrier may be installed within the line voltage section that shall provide isolation between normal and emergency circuits where indicated on plans.
C. Door Cover: Dead front screw-held or hinged locking cover.
D. Relay Capacity: Be available in sizes to accommodate 4, 8, 16, 24, 32, 40, 48, 56, and 64 relays.
E. Power Supply: Class 2 transformer capable of 120/277 VAC.
F. Control Module: Microprocessor-based, solid-state, 365-day timing and control unit. Time clock shall be protected against loss of time during an outage for a period up to 30 days without power of any type. Daylight savings time shall be adjustable. Non-volatile internal memory with backup and restore capability. Surge suppression protection.
G. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.
H. Provide UL924 controls to turn on emergency loads during power outage.

2.04 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
   1. Match color specified in Division 26 Section "Wiring Devices."
   2. Integral green LED pilot light to indicate when circuit is on.
   3. Internal white LED locator light to illuminate when circuit is off.
B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."

C. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices."
D. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."
E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.05 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 6 for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

PART 3 EXECUTION

3.01 WIRING INSTALLATION

A. Provide 120V power from critical branch panel.
B. Comply with NECA 1.
C. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
E. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
F. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
G. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
H. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.02 PLANNING / COORDINATION

A. The Contractor shall arrange a pre-installation meeting with the network lighting control vendor, and an Owner’s representative at the Owner’s facility to verify scheduling, installation criteria, and functionality. Meeting to occur at same time as pre-installation meeting for Division 26 Section “Lighting Control Devices”.

3.03 FIELD QUALITY CONTROL

A. The Manufacturer’s Representative shall submit a written test report that the system has been 100% tested, approved, and commissioned. The final test shall be witnessed by the Owner’s representative, Electrical Engineer, Electrical Contractor, and performed by the manufacturer’s representative. The final test report must be received and acknowledged by the Engineer prior to request for final payment. Perform all electrical and mechanical tests required by the equipment manufacturer. The installer shall prepare a checkout report and submit in triplicate, one copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:
    1. Test for circuit continuity.
    2. Verify that the control module features and relays are operational.
    3. Check operation of local override controls.
    4. Indication that photocells are properly located, adjusted and communicating with control modules.
    5. Test system diagnostics by simulating improper operation of several components selected by Architect.
    6. Indication that time schedules are functioning as decided at the pre-installation meeting.
    7. Installer’s name and date.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.05 DEMONSTRATION

A. Provide (4) hours training over a period of 2 sessions for Owner and maintenance personnel to adjust, operate, and maintain the lighting control system and equipment. Video tape training session and deliver videotape to Engineer as part of the Closeout Documents. Provide initial 2-hour field training. Provide an additional training session with a manufacturer's field representative 11 months after substantial completion for a minimum of 2 hours.

3.06 RECORD DRAWING DOCUMENTATION

A. After successful completion of all the tests and adjustments listed above, the Contractor shall submit the following information to the Engineer in the Operation, Maintenance and Warranty Data Manuals:
   1. Complete As-Built Wiring Diagrams.
   2. System Operating Manuals.
   3. Copy of the Test Report, as detailed above.

END OF SECTION 26 09 43

SECTION 26 24 13
SWITCHBOARDS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of a completely operational switchboard as shown, required, and specified herein.

B. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Instrumentation.
4. Identification.
5. Concrete bases.
6. Extra materials.

1.02 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Provide detail of enclosure types for types other than NEMA 250, Type 1.
3. Provide detail of bus configuration, current, and voltage ratings.
4. Provide detail of short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. If service entrance equipment, provide detail of utility company's metering provisions with indication of approval by utility company.
7. Disconnecting and overcurrent protective devices.
    a. Provide detail of short-circuit current rating of switchboards and overcurrent protective devices.
    b. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
    c. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.
8. Instrumentation.
9. Accessory components and features.
10. Identification. Provide schedule of nameplates.

C. Selective Coordination Study: Provide preliminary selective coordination study with shop submittal, indicating circuit breakers coordinate with critical and life safety distribution systems. Identify potential conflicts and provide suggested solutions.

D. Qualification Data: For qualified installer. (NFPA 70E training, Licensed Journeyman)

E. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Test Data: Results of thermal scan tests.

4. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.
5. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Submit record of transmittal as part of O&M Manual. Refer to "Extra Materials" article in Part 2 below.
6. Submit record of warranty as part of O&M Manual. Refer to "Warranty" article in Part 3 below.

1.04 QUALITY ASSURANCE

A. The equipment manufacturer shall be regularly engaged in manufacture of power distribution switchboards, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than 25 years.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
D. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

1.05 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
1. NECA 400 – Standard for Installing and Maintaining Switchboards.
2. NEMA AB-1 – Molded Case Circuit Breakers.
3. NEMA KS-1 – Enclosed Switches.
4. NEMA PB 2 – Dead Front Distribution Switchboards.
5. NEMA PB 2.1 – Instructions for Safe Handling, Installation, Operation and Maintenance of Dead Front Distribution Switchboards Rated 600V or less.
6. NFPA 70E – Standard for Electrical Safety in the Workplace.
7. NFPA 70 – National Electrical Code
8. UL 198E – Class R Fuses.
9. UL 860 – Standard for Service Equipment.
10. UL 891 – Standard for Dead Front Switchboards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
C. Handle and prepare switchboards for installation according to NEMA PB 2.

1.07 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

1.08 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
B. Environmental Limitations:
1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
a. Ambient Temperature: Not exceeding 104 deg F.
b. Altitude: Not exceeding 6600 feet.
C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two weeks in advance of proposed interruption of service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without written permission from Architect, Construction Manager and Owner.
4. Comply with NFPA 70E.

1.09 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 MAINTENANCE

A. Switchboard manufacturer / vendor shall:

1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
2. Make new replacement parts available for minimum of ten years from date of manufacture.
3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
4. Provide on-site service support within 24 hours anywhere in continental United States.
5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

1.11 WARRANTY

A. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide switchboards by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. American Midwest Power (A.M.P.).
6. Electro-Mechanical Industries, Inc. (E.M.I.)
7. States Electric Manufacturing Company.

2.03 SWITCHBOARD CONSTRUCTION AND RATINGS

A. See drawings for voltage, current, and AIC ratings.

B. Front-Connected, Front-Accessible ONLY Switchboards:

1. Main Devices: Panel mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Indoor Enclosures: Steel, NEMA 250, Type 1.
   1. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

D. Outdoor Enclosures (where indicated): Type 3R.
   1. Finish: Finish and color selected by Architect from manufacturer’s standard palette. Factory-applied finish; undersurfaces treated with corrosion-resistant undercoating.
   2. Enclosure: Downward, rearward sloping roof; bolt-on rear covers for each section, with provisions for padlocking.
   3. Doors: Personnel door at each end of aisle, minimum width of 30 inches; opening outwards; with panic hardware and provisions for padlocking.
   4. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
      a. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
      b. Space-Heater Power Source: Transformer, factory installed in switchboard.

E. Utility Metering Compartment (where indicated): Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

F. Customer Metering Compartment (where indicated): A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. If necessary include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

G. Bus Transition and Incoming Pull Sections as required for underground supply: Matched and aligned with basic switchboard.

H. Removable, Hinged Rear Doors and Compartment Covers:
   1. Required for rear-access switchboards only.
   2. Secured by captive thumb screws, for access to rear interior of switchboard.

I. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

J. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
   2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   3. Ground Bus: 1/4-by-2-inch- hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
   4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

K. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.04 SURGE PROTECTIVE DEVICE

A. Provide SPD Protection (at services, life safety switchboards, and where indicated); see Specification Section 26 43 13 for requirements.

B. Include 60A overcurrent protection device within switchboard as a dedicated disconnecting means for SPD unless explicitly noted otherwise.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES – MAIN

A. Main disconnecting and overcurrent protective devices used as service equipment shall be listed and labeled for such use.

B. Main Lug Only (MLO): where indicated.

C. Main Fused Switch (MFS): where indicated

1. For main switches less than 1200A:
    a. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
2. For main switches 1200A or greater:
    a. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
        1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
            (a) Boltswitch, Inc.
            (b) Eaton Electrical Inc.; Cutler-Hammer Business Unit.
            (c) Pringle Electrical Manufacturing Company, Inc.
            (d) Siemens Energy & Automation, Inc.
            (e) Square D; a brand of Schneider Electric.
        2) Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
        3) Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
            (a) Electrical Trip: For switches with ground fault protection or remotely tripped switches. Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
            (b) Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
        4) Auxiliary Switches (where indicated): Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
        5) Open-Fuse Trip Device (where indicated): Arranged to trip switch open if a phase fuse opens.
        6) Ground-Fault Relay:
            (a) Provide at all equipment rated 480V, 1000A or more, or where indicated on plans.
            (b) Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
            (c) Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
            (d) No-Trip Relay Test (where indicated): Permits ground-fault simulation test without tripping switch.
            (e) Test Control (where indicated): Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

D. Main Circuit Breaker (MCCB): where indicated.

1. Comply with IEEE C37.13.
2. Ratings: Continuous ampacity as indicated on plans. Interrupting and short-time current ratings for each circuit breaker as indicated on plans. Voltage and frequency ratings same as switchgear.

3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. ABB Inc.
    b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    c. Siemens Energy & Automation, Inc.
    d. Square D; a brand of Schneider Electric.
4. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
    a. Normal Closing Speed: Independent of both control and operator.
    b. Slow Closing Speed: Optional with operator for inspection and adjustment.
    c. Stored-Energy Mechanism: Electrically charged, with optional manual charging.
    d. Operation counter.
5. Trip Devices: Solid-state, over-current trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
    a. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
    b. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
    c. Field-adjustable, time-current characteristics.
    d. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
    e. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
    f. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I2t operation.
    g. Pickup Points: Five minimum, for instantaneous-trip functions.
    h. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
    i. Frame sizes 1200A or larger shall include arc reduction maintenance switch function imbedded to meet NEC 240.87.
6. Auxiliary Contacts (where indicated): For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

2.06 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES – DISTRIBUTION

A. Molded-Case Circuit Breaker (CB, where indicated): Comply with UL 489, with interrupting capacity to meet available fault currents. Frame sizes 1200A or larger shall include arc reduction maintenance switch function to meet NEC 240.87.
    1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
    3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
        a. Instantaneous trip.
        b. Long- and short-time pickup levels.
        c. Long- and short-time time adjustments.
        d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers (where indicated): Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers (where indicated): Class B ground-fault protection (30-mA trip).
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing (where indicated): Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    e. Auxiliary Contacts (where indicated): One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.07 INSTRUMENTATION

A. Multifunction Digital-Metering Monitor (where indicated): Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    a. Phase Currents, Each Phase: Plus or minus 1 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    d. Megawatts: Plus or minus 2 percent.
    e. Megavars: Plus or minus 2 percent.
    f. Power Factor: Plus or minus 2 percent.
    g. Frequency: Plus or minus 0.5 percent.
    h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
    j. Contact devices to operate remote impulse-totalizing demand meter.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
3. Integrate into Building Automation System. Refer to Div 23 for requirements.

2.08 CONCRETE BASES

A. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section.
1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported unit. Chamfer top edge and corners of pad.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.

2.09 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of switchboard cabinet lock (if present).
   2. Spare Circuit Breakers shall be as shown on Drawings.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Switchboards shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

C. Panels shall be used for the voltage of which they are designed. The use of 480/277V panels on lesser voltages is not allowed.

3.02 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboard(s) before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

C. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

D. Install filler plates in unused spaces of panel-mounted sections.

E. Install overcurrent protective devices and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install surge protection as specified in related sections.

G. Comply with NECA 1.

3.04 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

3.05 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

C. Switchboard Nameplates:
   1. Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems".
   2. Label service entrance switchboards with available fault current information as well as the date the fault calculation was performed. Do not use fault current rating of equipment for this value. If value is not readily available on plans obtain from project engineer, or if applicable from engineer as specified in 260573 “Overcurrent Protective Device Coordination Study”.

D. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.06 INFRARED SCANNING

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels (and rear, where applicable) so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:
        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 ADJUSTING AND CLEANING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Upon completion of installation of switchboard, de-energize equipment and inspect interiors of switchboard; clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

C. Adjust Circuit Breaker trip and time-delay settings to values as instructed by the Architect/Engineer.

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 24 13

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SCOPE

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Electronic-grade surge-suppression panelboards.

B. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of completely operational panelboards as shown, required, and specified herein.

1.02 SUBMITTALS

A. Provide product data for each type of panelboard, switching and overcurrent protective device, accessory, and component indicated.

B. Shop Drawings shall be submitted for each panelboard; including:
   1. Include dimensioned plans, elevations, and details, including required wiring space / gutter clearances.
   2. Provide current and voltage ratings.
   3. Provide short-circuit current rating of overcurrent protective devices.
   4. Provide panelboard ancillary equipment options, including hinged trim, feed thru lugs, shunt-trip breakers, GFCI, etc. See schedules for specific requirements.
   5. Panelboard schedules.

C. Selective Coordination Study: Provide preliminary selective coordination study with shop submittal, indicating circuit breakers coordinate with critical and life safety distribution systems. Identify potential conflicts and provide suggested solutions.

D. Field Quality Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance and Warranty Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Test Data: Results of thermal scan tests.
   3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.03 QUALITY ASSURANCE

A. Manufacturer of panelboards shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.

B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.

C. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.

D. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

1.04 DELIVERY, STORAGE AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; if storage conditions require it install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.05 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature:
         1) For panels with fused switches: Not exceeding minus 22 deg F to plus 104 deg F.
         2) For panels with circuit breakers: Not exceeding 23 deg F to plus 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify General Contractor/Construction Manager no fewer than ten working days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.06 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. NEMA AB 1 – Molded Case Circuit Breakers.
   2. NEMA KS 1 – Enclosed Switches.
   3. NEMA PB 1 – Panelboards.
   4. NEMA PB 1.1 – Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600V or Less.
   5. UL 489 – Molded Case Circuit Breakers.

1.07 MAINTENANCE

A. Panelboard manufacturer / vendor shall:
   1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
   2. Make new replacement parts available for minimum of ten years from date of manufacture.
   3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
   4. Provide on-site service support within 24 hours anywhere in continental United States.
   5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

1.08 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide panelboards by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

2.03 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Kitchen/Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
   2. Finishes:
      a. Panels and Trim: Steel or galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Same finish as panels and trim.
   3. Panelboard Cover: Entire front trim with door within door cover.
   4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top or bottom (contractor's discretion).

C. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. Neutral Bus:
      a. Normally rated 100 percent of phase bus unless otherwise indicated.
      b. Extra-Capacity Neutral Bus (for electronic grade panelboards and where otherwise indicated): Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Main and Neutral Lugs: Mechanical type.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   4. Feed-Through Lugs (where indicated): Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   5. Subfeed (Double) Lugs (where indicated): Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   6. Extra-Capacity Neutral Lugs (for electronic grade panelboards and where otherwise indicated): Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

E. Service Equipment Label (where indicated): NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices. Only applicable to panels used as service entrance equipment, coordinate with plans.

F. Provisions for Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Provide 65kAIC unless noted otherwise.
H. See drawings for voltage, current, AIC ratings, flush or surface mounting, schedules, nameplates, environmental conditions, MLO, feed-thru lugs, future space / spare / overcurrent devices, etc.

2.04 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.
B. Mains: Circuit breaker, fused switch, or main lugs only (as indicated on drawings).
C. Branch Overcurrent Protective Devices (as indicated on drawings):
    1. Bolt-on circuit breakers.
    2. Fused switches.
D. Surge Protection Device (where indicated and required for all life safety panels): Integrally mounted, plug-in, solid-state, parallel-connected type as specified in Section 26 24 13 “Surge Protective Devices for Low-Voltage Electrical Power Circuits”.
    1. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.

2.05 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. The following general requirements apply to all lighting and appliance branch-circuit panelboards:
    1. Factory assembled and dead front safety type.
    2. Bolt-on breakers unless otherwise noted.
    3. With adequate wire bending space based on maximum overcurrent device capable of being installed.
    4. Pre-knocked out panelboard tops or bottoms shall not be permitted.
    5. Hinged trim (door-in-door) type unless otherwise noted.
    6. Trims:
        a. Flush trims: concealed clamp and hinges, flush lock, and primer finish.
        b. Surface: factory painted in manufacturer's standard color.
    7. If containing breakers that serve as sole disconnecting means, provide permanent means to lock breakers open.
    8. Field verify incoming feeder location for each panelboard.
    9. Provide typed directory card inside panelboard door, mounted in metal frame with transparent protective cover.
    10. If doors more than 48” high, have vault-type latch. Otherwise, have flush latch. Latches shall be keyed alike.
    11. Surge Protection Device (where indicated and required for all life safety panels): Integrally mounted, plug-in, solid-state, parallel-connected type as specified in Section 26 24 13 “Surge Protective Devices for Low-Voltage Electrical Power Circuits”.
B. Electronic-Grade Panelboards (where indicated):
    1. Panelboards: NEMA PB 1; with factory-installed, integral surge suppression; labeled by an NRTL for compliance with UL 67 after installing surge suppression.
    2. Buses:
        a. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
        b. Copper equipment and isolated ground buses.
    3. Surge Protection Device: Integrally mounted, plug-in, solid-state, parallel-connected type as specified in Section 26 24 13 “Surge Protective Devices for Low-Voltage Electrical Power Circuits”.

2.06 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. See drawings for voltage, current, AIC ratings, GFCI, GFPE, Shunt-Trip, Handle Ties, Lock-On/Offs, switch rated, etc.
B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents:
    1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Suitable for number, size, trip ratings, and conductor materials.
    c. Ground-Fault Protection: Integrally mounted relay and trip-unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    d. Arc reduction maintenance switch function to meet NEC 240.87 for breaker frame sizes 1200 A and larger.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Panelboards shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

C. Panels shall be used for the voltage of which they are designed. The use of 480/277V panels on lesser voltages is not allowed.

3.02 PROJECT CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

3.03 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.04 INSTALLATION OF PANELBOARDS

A. Mount panelboards and cabinets to building structure or interior wall construction. Mount independent of conduit and raceways entering boxes. Where indicated, provide free standing Plywood/Unistrut backboards (painted with fire retardant grey) rigidly mounted to the floor and/or ceiling for panelboard support means.

B. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

C. Mount panelboards with cabinet top at 78" above finished floor.

D. Provide 1" spare empty conduits from each flush mounted panelboard. When the floor is on grade, provide three (3) conduits into the ceiling cavity above. When the floor has accessible space below, provide two (2) conduits into the ceiling cavity above and two (2) conduits into the accessible space below the floor. Ends shall be capped and shall be tagged at both ends with permanent tags.

E. Provide three spare empty 1” conduits from surface mounted panelboard into accessible ceiling space or space designated to be ceiling space.

F. Provide each circuit in the panel(s) with a circuit number securely fastened to the breaker for identification purposes.

G. Provide a circuit directory dated and completely typed on the interior of each panel door.

H. Verify with owner critical circuits, for application of “lock-ons”. (Telecommunication circuits, Fire Alarm, Security, HVAC, etc.)

I. Install filler plates in unused spaces.

J. Comply with NECA 1.

3.05 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads. Use template indicated at the end of this specification section.

1. Incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
2. Provide 8x11 panel directory in 8x11 plastic sleeve. Secure sleeve to inside cover of panelboard with appropriate materials.
3. Free template (Excel format) is available upon request from engineer for contractor’s use.
4. Coordinate with engineer for fault current and date of study.
5. Document accurate feeder lengths (within 10’) as best possible.
6. For existing panels requiring addition of more than five circuits field verify all information as reasonably possible.
7. Submit final copy of each directory as part of O&M Manual.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.06 FIELD QUALITY CONTROL

A. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Inspect Completed Installation for physical damage, proper alignment, anchorage, and grounding.

C. Check Tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

D. Test Ground Fault Systems by operating push-to-test button.

E. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Include test results in Operation, Maintenance and Warranty Data Manuals.

F. Balancing Loads: After Substantial Completion, but not more than two months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
   1. Perform measurements during period of normal working load as advised by the Owner.
   2. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as FAX machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference between phase loads exceeding 20 percent within any one panelboard is not acceptable. Re-balance and re-check as required to meet this minimum requirement.

3.07 ADJUSTING AND CLEANING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust Circuit Breaker trip and time-delay settings to values as instructed by the Architect/Engineer.

C. Upon completion of installation of panelboard, de-energize equipment and inspect interiors of panelboard; clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain panelboards, overcurrent protective devices, and accessories. Include a 4 hour session.

3.09 WARRANTY

A. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Warranty period shall begin on the date of acceptance as issued by the Architect’s certificate of completion.

3.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Spare Circuit Breakers shall be as shown on Drawings.

END OF SECTION 26 24 16

SECTION 26 27 01
ELECTRICAL UTILITY COORDINATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes underground electrical service requirements that will be installed to serve the facility.

B. Related Sections include the following:

1. Division 26 Section "26 05 00" – General Requirements
2. Division 26 Section "26 05 19" – Electrical Power Conductors
3. Division 26 Section "26 05 26" – Grounding and Bonding
4. Division 26 Section "26 05 33" – Raceways & Boxes for Electrical Systems
5. Division 26 Section "26 24 13" – Switchboards

1.02 SUBMITTALS

A. Product Data: For the following:

1. Connection Cabinet
2. CT Cabinet
3. Meter Socket

1.03 PROJECT CONDITIONS

A. New Construction.

1.04 COORDINATION

A. Coordinate location of electrical service including transformer with the drawings, Engineer, Architect and Utility Company.

B. Coordinate exact dimensions and construction requirements of transformer pad with the local utility.

C. Coordinate location of the transformer and minimum clearance requirements with the local utility.

D. The service connections shall be installed in strict accordance with the rules of the power company.

PART 2 PRODUCTS

2.01 TRANSFORMER CONNECTION CABINET

A. Acceptable Manufacturers:

1. States Electric
2. AMP
3. EMI

B. Provide a transformer connection cabinet if required by the Utility Company. Connection cabinet shall meet requirements of Utility Company. Refer to 26 24 13 Switchboards for basic constructability requirements.

2.02 CURRENT TRANSFORMER / METERING CABINET

A. Acceptable Manufacturers:

1. States Electric
2. AMP
3. EMI
4. Square D

B. Provide a meter cabinet as required by the Power Company.

C. Meter cabinet shall be weatherproof / rustproof with lockable removable access cover.

D. Provide a raceway as required between the meter cabinet and transformer.

E. Provide raceways and connections from the meter cabinet to the switchboard serving the building.

F. Locate utility metering and current transformers in the cabinet. Coordinate with the utility.

PART 3 EXECUTION

3.01 INSTALLATION

A. The service connections shall be installed in strict accordance with the rules of the Utility. Initiate and take responsible charge for all negotiations with the Utility with regard to the service connections, and initiate the necessary requests to the Utility for the work which will be performed by them.

B. The underground electrical service shall be installed from the local utility service to the building service entrance equipment. The equipment shall be provided and installed by the Power Company (Utility) or Electrical Contractor (Contractor) as scheduled below. Verify all responsibilities with Utility prior to bid.

		Furnished By	Installed By
1.	Site Restoration	Contractor	Contractor
2.	Primary Service Trenching	Utility	Utility
3.	Primary Raceways / Pull Boxes	Utility	Utility
4.	Primary Electrical Cable	Utility	Utility
5.	Transformer Pad	Contractor	Contractor
6.	Grounding Grid @ Transformer	Contractor	Contractor
7.	Pad Mounted Transformer	Utility	Utility
8.	Primary Connections @ Transformer	Utility	Utility
9.	Secondary Connections @ Transformer	Contractor	Contractor
10.	Secondary Service Trenching	Contractor	Contractor
11.	Secondary Electrical Conductors	Contractor	Contractor
12.	Secondary Raceways	Contractor	Contractor
13.	Electrical Meter(s)	Utility	Utility
14.	Electrical Meter Socket	Contractor	Contractor
15.	Metering C.T. Cabinet	Contractor	Contractor
16.	Current Transformers (utility meter)	Utility	Contractor
17.	Metering Conductor Raceway	Contractor	Contractor
18.	Metering Conductors	Contractor	Contractor
19.	Connection Cabinet (C.C.)	Contractor	Contractor
20.	Raceway from CC to Transformer	Contractor	Contractor

C. When connection boxes are required the concrete pad shall be poured integral with the transformer pad with proper reinforcing rods in a grid pattern end to end and side to side. Template for concrete transformer pad will be furnished by the utility.

3.02 SERVICE CHARGES

A. Fees and charges submitted by the Utility for the work associated with new or relocated metering for this project shall be responsibility of Contractor. All other fees shall be borne by the Owner.

B. Electrical contractor shall coordinate exact requirements with the utility. No extra charges will be allowed because of the failure of the contractor to contact the Utility and determine what will be required to complete the service installation.

C. Charges (the electric bill) for power consumed during the construction of this project will be borne by the Owner.

3.03 GROUNDING

A. Provide grounding as required by the Utility, National Electrical Code.

B. Ground equipment according to Division 26 05 26 Section "Grounding and Bonding."

END OF SECTION 26 27 01

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installation of all labor, materials, hardware, and ancillary equipment for and incidental to the delivery, installation, and connection of wiring devices as described herein.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for approval for all wiring devices as follows:
   1. Receptacles.
   2. USB charging outlets.
   3. Twist-locking receptacles.
   4. Floor service outlets.
   5. Poke-through assemblies.
   6. Multi-outlet assemblies.
   7. Wall plates and finishes.

B. Samples of any or all proposed equipment or system components, in each color specified, shall be submitted for examination/approval as requested.

C. As-Built Drawings: Plans indicating conduit routing for floor-box and poke-throughs.

D. Operation, Maintenance and Warranty Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.03 QUALITY ASSURANCE

A. The equipment manufacturer shall be regularly engaged in manufacture of wiring devices, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than ten years.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

1.04 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. FS W-C-596 – Electrical Power Connector, Plug, Receptacle, and Cable Outlet.
   2. NEMA WD 1 – General-Purpose Wiring Devices.
   3. NEMA WD 5 – Specific-Purpose Wiring Devices.
   4. UL 498 – Attachment Plugs and Receptacles.
   5. UL 943 – Class A Ground-Fault Circuit-Interrupters.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory’s label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

B. Provide new wiring devices at each outlet / opening indicated on the drawings. Devices shall be UL listed, and installed in accordance with NEC Article 404 and 406. Unless otherwise noted, all devices shall be industrial specification grade and of one manufacturer.

2.02 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.03 STRAIGHT BLADE RECEPTACLES

A. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 8310 (single), 8300 (duplex).
      b. Hubbell; HBL8310 (single), HBL8300 (duplex).
      c. Leviton; 8310 (single), 8300 (duplex).
      d. Pass & Seymour; 8301 (single), 8300H (duplex).
      e. See plan for GFCI requirement. Provide Leviton 7899-HG or equal.
   2. Description: Straight blade and with one-piece brass ground, wide bodied.
   3. All receptacles shall be 20A rated unless noted otherwise.
   4. Tamper-Resistant Receptacles: All receptacles shall be tamper-resistant.
   5. All devices in damper or wet locations shall be of the weather-resistant type.
   6. Devices shall have external screw pressure plate back wired clamps.

2.04 USB CHARGING OUTLETS

A. Hospital-Grade, tamper-resistant duplex straight blade receptacle with dual USB charger ports:
   1. Hubbell USB8300AC5 or equal.
      a. 20A duplex receptacle with dual 5.0A (one Type A, one Type C) USB charging ports.
      b. LED Indicator Light
      c. Tamper resistant shutters (where required).
      d. Listed to UL498 and UL1310.

2.05 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; L520R.
      b. Hubbell; HBL2310.
      c. Leviton; 2310.
      d. Pass & Seymour; L520-R.

2.06 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.07 FLOOR BOXES

A. Manufacturers:
   1. Wiremold Legrand RFB4 or RFB11 series or equal, sized per device quantities and requirements.
   2. Hubbell Incorporated; Wiring Device-Kellems.
   3. Pass & Seymour/Legrand; Wiring Devices & Accessories.
   4. Square D/ Schneider Electric.

B. Product Description:
   1. Type: Modular, flush-type, single- or dual-service units (as indicated) suitable for wiring method used.
   2. Compartments: Barrier separates power from voice and data communication cabling.
   3. Service Plate: Rectangular, die-cast aluminum with satin finish unless noted otherwise indicated.
   4. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
   5. Low-Voltage Outlets: as indicated on plans.
   6. Furniture feed coverplates and associated whip where required for connection to furniture.
   7. Provide separate conduits for power and low-voltage.

C. Refer to drawings for types and locations.

2.08 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide Wiremold Legrand AT series or approved equal. Sized to match device requirements, see plans.
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
   3. Square D/ Schneider Electric.

B. Product Description:
   1. Type: Factory-fabricated and -wired assembly of below-floor junction box with single- or multi-channeled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
   2. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks, or as indicated on plans.
   3. Compartments: Barrier separates power from voice and data communication cabling.
   4. Size: Selected to fit nominal cored holes in floor, see Drawings, and matched to floor thickness.
   5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   6. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
   7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.
   8. Service Plate: Rectangular, die-cast aluminum with satin finish unless noted otherwise indicated.
   9. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
   10. Low-Voltage Outlets: as indicated on plans.
   11. Furniture feed coverplates and associated whip where required for connection to furniture.
   12. Provide separate conduits for power and low-voltage.

2.09 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.

B. Wiremold Company (The).

C. Product Description:
   1. Non-metallic raceway with all fittings, corners, cutting tools, coverplates, etc as necessary for a complete installation.
   2. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
   3. Provide single channel and dual channel raceways as noted on plans. Coordinate line and low voltage channel requirements with plans.
      a. Raceways shall have devices mounted every 30” or as noted on plans.
      b. Line voltage channels shall contain pre-wired devices, wired with No. 12 AWG and circuited with one or more circuits as indicated on plans.
      c. Low voltage channels shall contain blank faceplates for field wiring and device installation.

2.10 WALL PLATES AND FINISHES

A. Finishes:
   1. Color: Wiring device catalog numbers in Section Text do not designate device color. Verify color with Drawings and Architect.
      a. Normal Devices: Light Ivory
      b. Emergency Devices: Red.

B. Wall Plates:
   1. Single and combination types to match corresponding wiring devices.
      a. Plate-Securing Screws:
         1) Metal with head color to match plate finish.
         2) Provide security-type screw heads in secure detention spaces.

b. Material for Finished Spaces:
1) 0.035-inch-thick, satin-finished type 302 non-magnetic stainless steel for kitchen, mechanical and electrical room locations.
2) Smooth, unbreakable nylon thermoplastic for all other locations, light ivory finish.
c. Material for Gymnasiums: Heavy-duty high-strength polycarbonate/nylon blend. White finish. Cortech Tiger Series or equal.
d. Material for Unfinished Spaces: Galvanized steel.
e. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

2. Wet-Location, Weatherproof Cover Plates: NEMA 250, gasketed, complying with type 3R weather-resistant impact resistant polycarbonate with stainless steel mounting screws.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Wiring Devices shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

3.02 INSTALLATION OF WIRING DEVICES

A. Install devices in accordance with the NEC and as specified. The ground terminal of each device shall be bonded to the outlet box with an approved green bonding jumper, and connected to the green equipment grounding conductor.

B. See Drawings for mounting height of devices. If not noted, mounting heights and installation locations shall comply with NECA 1 and ADA. Mount devices shown in new locations at the indicated approximate heights to the centerline of the device. Specified heights may be adjusted + or - 2 " to meet masonry coursing; however, all similar devices shall be mounted at the same height. The Contractor is cautioned that in many cases obstructions occur either above or below the outlet and the drawings must be carefully checked for interference prior to adjusting any outlet height.

C. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

D. Conductors:
1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

E. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails.
5. When there is a choice, use pressure plate termination.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

F. GFCI Installation:
1. Where GFCI devices are located in inaccessible locations (vending machines, kitchen equipment, etc) provide and label remote test stations at a location agreed upon by Owner and Electrical Inspector.

G. Floor Box and Poke-Through Installation:
1. Floor boxes and poke-throughs shall be determined from dimensioned plans as directed by Architect. Contractor shall request dimensioned plans in a timely manner from Architect.
2. For poke-throughs with penetrations into inaccessible ceilings route conduits to nearest accessible space. Label conduits and include in as-built drawings.
3. Install with bead of silicon caulk to prevent water leakage.

H. Device Plates:
1. Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
2. Provide blank coverplates over all unused Div 26, 27 and 28 openings.

3.03 IDENTIFICATION

A. Comply with device labeling requirements found in Division 26 Section "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Test Instruments: Use instruments that comply with UL 1436, Outlet Circuit Testers and Similar Indicating Devices.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
1. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943, Ground Fault Circuit Interrupters.
2. Using the test plug, verify that the device is wired properly.

3.05 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
1. Cord and Plug Sets: Match equipment requirements.

END OF SECTION 26 27 26

SECTION 26 28 13
FUSES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers and motor-control centers.
   2. Extra materials.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   3. Current-limitation curves for fuses with current-limiting characteristics.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   4. Coordination charts and tables and related data.
   5. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Submit record of transmittal as part of O&M Manual. Refer to “Extra Materials” article in Part 2 below.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with NEMA FU 1 for cartridge fuses.
D. Comply with NFPA 70.
E. Comply with UL 248-11 for plug fuses.

1.05 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.06 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Littelfuse, Inc.
   4. Mersen, Inc.

2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 5 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Service Entrance: Class L, time delay.
   2. Feeders: Class RK1, time delay.
   3. Motor Branch Circuits:
      a. Motors with Variable Frequency Drives: Type JJC, Class T.
      b. All other Motors: Class RK5, time delay.
   4. Other Branch Circuits: Class RK5, time delay.
   5. Control Circuits: Class CC, time delay.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of completely operational enclosed switches and circuit breakers as shown, required, and specified herein.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for approval for all enclosed switches and circuit breakers as follows:
   1. Fusible switches.
   2. Non-fusible switches.
   3. Shunt trip switches.
   4. Molded-case circuit breakers (MCCBs).
   5. Molded-case switches.
   6. Enclosures.

B. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, details, wiring diagrams, attachments to other work, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

C. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.03 CLOSEOUT SUBMITTALS

A. Operation, Maintenance and Warranty Data: For enclosed switches and circuit breakers to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance and Warranty Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Test Data: Results of thermal scan tests.
   3. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.04 QUALITY ASSURANCE

A. Manufacturer of enclosed switches and circuit breakers shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.

B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.

C. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.

D. Source Limitations: Obtain enclosed switches and circuit breakers from single source from single manufacturer.

1.05 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. NEMA AB 1 – Molded Case Circuit Breakers.
   2. NEMA KS 1 – Enclosed Switches.
   3. NEMA PB 1 – Panelboards.

4. NEMA PB 1.1 – Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600V or Less.
5. UL 489 – Molded Case Circuit Breakers.
6. NFPA 70E – Standard for Electrical Safety in the Workplace.
7. NFPA 70 – National Electrical Code

1.06 MAINTENANCE

A. Manufacturer of enclosed switches and circuit breakers shall:
1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
2. Make new replacement parts available for minimum of ten years from date of manufacture.
3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
4. Provide on-site service support within 24 hours anywhere in continental United States.
5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

1.07 WARRANTY

A. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Warranty period shall begin on the date of acceptance as issued by the Architect's certificate of completion.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide enclosed switches by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

2.03 FUSIBLE / NON FUSIBLE SWITCH CONSTRUCTION AND RATINGS

A. See drawings for number of poles, number of throw, voltage, current, AIC ratings, mounting, nameplates, environmental conditions, etc.

B. General Fusible Switch Construction shall be:
1. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Class R Fuse Kit (if fusible): Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit (where indicated): One NO/NC (Form "C") auxiliary contact, arranged to activate before switch blades open.

2.04 MOLDED-CASE CIRCUIT BREAKERS

A. See drawings for number of poles, voltage, current, AIC ratings, GFI or GFP, mounting, nameplates, environmental conditions, etc.

B. General Molded-Case Circuit Breaker Construction shall be:
1. Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable, Instantaneous-Trip Circuit Breakers (where indicated): Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers (where indicated): Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

C. Features and Accessories:
1. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
2. For breaker frame sizes 1200A and larger provide arc reduction maintenance switch function to meet NEC 240.87.
3. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
4. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
5. Auxiliary Contact Kit (where indicated): One NO/NC (Form "C") auxiliary contact, arranged to activate before switch blades open.

2.05 MOLDED-CASE SWITCHES

A. See drawings for number of poles, voltage, AIC ratings, mounting, nameplates, environmental conditions, etc.

B. General Molded-Case Switch Construction shall be:
1. Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
2. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:
1. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
2. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
3. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
4. Auxiliary Contact Kit (where indicated): One NO/NC (Form "C") auxiliary contact, arranged to activate before switch blades open.

2.06 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen, Wash-Down Areas: NEMA 250, Type 4X, Stainless Steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9 (or as required by construction or indicated on drawings).

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Enclosed switches and circuit breakers shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

3.02 EXAMINATION / COORDINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each enclosed switch / circuit breaker.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where enclosed switch / circuit breaker will be installed. Coordinate installation of wall-mounting and structure-hanging supports with actual enclosure provided. Coordinate layout and installation of enclosed switch / circuit breaker with other construction including conduit, piping, equipment, and adjacent surfaces.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

3.03 APPLICATIONS

A. Select features of each enclosed switch / circuit breaker to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.04 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING AND CLEANING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
B. Upon completion of installation of panelboard, inspect interiors of enclosed switch / circuit breaker; clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.
C. Adjust Circuit Breaker trip and time-delay settings to values as instructed by the Architect/Engineer.

END OF SECTION 26 28 16

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of completely operational enclosed controllers, starters, as shown, required, and specified herein.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for approval for all enclosed controllers as follows:
   1. Across-the-line, manual and magnetic starters.

B. For each type of enclosed controller, accessory, and component indicated. Include dimensioned elevations, sections, weights, details, wiring diagrams, attachments to other work, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Nameplate legends
   5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

C. Operation, Maintenance and Warranty Data: For enclosed controller to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance and Warranty Data," include the following:
   1. Manufacturer's written instructions for testing, adjusting, and routine maintenance of enclosed controllers.
   2. Test Data: Results of thermal scan tests.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.03 QUALITY ASSURANCE

A. Manufacturer of enclosed controllers shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.

B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.

C. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.

D. Source Limitations: Obtain enclosed controllers from single source from single manufacturer.

E. Comply with NFPA 70.

1.04 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. NEMA ICS-6 – Enclosure of Industrial Controls and Systems.
   2. NEMA ICS 2 –Industrial Control Devices, Controllers, and Assemblies.
   3. NEMA KS 1 – Enclosed Switches.
   4. UL 198E – Class R fuses.

1.05 MAINTENANCE

A. Enclosed controller manufacturer / vendor shall:
   1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
   2. Make new replacement parts available for minimum of ten years from date of manufacture.
   3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
   4. Provide on-site service support within 24 hours anywhere in continental United States.
   5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide enclosed switches by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

2.03 ACROSS-THE-LINE MAGNETIC STARTER CONSTRUCTION AND RATINGS

A. See drawings for number of poles, number of throw, voltage, current, AIC ratings, mounting, nameplates, environmental conditions, push-buttons, pilot lights, selector switches, control transformers, etc.

B. General Across-The-Line Magnetic Starter Construction shall be:
   1. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
      a. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
   2. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
      a. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
      b. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
   3. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
      a. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
      b. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
      c. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

C. General Across-The-Line Magnetic Starter Construction shall be:
   1. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
   3. (If fusible) Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   5. Control/Indication: Provide a HOA selector switch and green "run" pilot light.

2.04 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.05 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
D. Control Relays: Auxiliary and adjustable time-delay relays.

2.06 FACTORY FINISHES

A. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Enclosed controllers shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.
B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in fusible devices.

3.02 EXAMINATION / COORDINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each enclosed controller.
B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where enclosed controller will be installed. Coordinate installation of wall-mounting and structure-hanging supports with actual enclosed controller provided. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces.
D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

3.03 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
B. Select horsepower rating of controllers to suit motor controlled.

3.04 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.05 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.06 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections on conductors larger than #4 and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

B. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 ADJUSTING AND CLEANING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Upon completion of installation of panelboard, inspect interiors of enclosed controller; clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 29 13

SECTION 26 32 13
ENGINE GENERATORS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing of an electric generating set of the type and operating characteristics described hereinafter, completely installed, tested, and operative. All necessary equipment, labor, and materials shall be included; the coordination of all required equipment and material shall be the responsibility of one manufacturer, who has had an approved experience record in furnishing similar equipment. Capacity and voltage characteristics shall be as shown on the drawings. Contractor shall provide the required permits, generator modeling, and associated costs to install the new generator. The Registration Permit will require Dispersion Modeling using the EPA SCREEN 3 model.

B. This Section includes a packaged engine-generator set for a Level 1 emergency power supply system with the following features:
   1. Fuel source: Diesel engines.
   2. Unit-mounted cooling system.
   3. Unit-mounted control and monitoring panel.
   4. Performance requirements for sensitive loads.
   5. Base mounted fuel oil tank.
   6. Outdoor enclosure.
   7. Temporary generator.

C. Concrete Bases:
   1. Equipment Mounting: Install generator on concrete base. Comply with requirements for concrete base specified in Division 03 Section. Concrete shall be 4,500 minimum PSI with synthetic microfiber reinforcement.
      a. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported unit. Chamfer top edge and corners of pad.
      b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
      c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
      d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      e. Install anchor bolts to elevations required for proper attachment to generator.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Thermal damage curve for generator.
   3. Time-current characteristic curves for generator protective device.
   4. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
   5. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   6. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
   7. Wiring Diagrams: Power, signal, and control wiring.

B. Selective Coordination Study: Provide preliminary selective coordination study with shop submittal, indicating circuit breakers coordinate with critical and life safety distribution systems. Identify potential conflicts and provide suggested solutions.
C. Qualification Data: For installer and manufacturer**.**
D. Source quality-control test reports.
    1. Certified summary of prototype-unit test report.
    2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
    3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
    4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements
    5. Report of sound generation.
    6. Report of exhaust emissions showing compliance with applicable regulations.
    7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
    8. Field Quality C
    9. Field quality-control test reports.
E. Operation, Maintenance, and Warranty Data: For packaged engine generator to include in emergency, operation, maintenance, and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance, and Warranty Data," include the following:
    1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
F. Warranty: Special warranty specified in this Section.

1.03 QUALITY ASSURANCE

A. Manufacturer of engine generators shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.
B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.
C. Installer Qualifications:
    1. An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.
    2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
    3. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
    4. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
D. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
E. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
F. Comply with NFPA 37 and 70.
G. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
H. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
I. Noise Emission: Comply with applicable state and local government requirements for maximum noise level due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
J. Comply with UL2200.

1.04 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
   1. Ambient Temperature: -20F to 100F.
   2. Altitude: Sea level to 1000 feet
   3. Do not deliver or install interior engine-generator sets until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above engine-generators is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving engine-generators into place.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Architect, Construction Manager, and Owner no fewer than two weeks in advance of proposed interruption of service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without written permission from Architect, Construction Manager and Owner.
   4. Comply with NFPA 70E.

1.05 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. ASME B15.1 – Safety Standard for Mechanical Power Transmission.
   2. NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
   3. NFPA 110 – Standard for Emergency and Standby Power Systems.
   4. UL 2200 – Stationary Engine Generator Assemblies

1.06 MAINTENANCE

A. Engine generator manufacturer / vendor shall:
   1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
   2. Make new replacement parts available for minimum of ten years from date of manufacture.
   3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
   4. Provide on-site service support within 24 hours anywhere in continental United States.
   5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.
   6. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.07 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Provide base thickness and size as recommended by generator supplier as a minimum or as indicated. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03. Coordinate layout and installation of generator with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 2 years from date of Substantial Completion.

2. Provide to Owner, an optional extended warranty of (1), (2) and (3) years beyond 2 year warranty. Owner is not obligated to accept this extended warranty.

1.09 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide complete generator set by one of the following:
   1. Caterpillar; Engine Div.
   2. Kohler Co.; Generator Division.
   3. MTU Onsite Power.
   4. Onan/Cummins Power Generation; Industrial Business Group.

2.03 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set. Vertical height shall be able to accommodate space indicated.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated on drawings with capacity as required to operate as a unit as evidenced by records of prototype testing.
   2. Output Connections: Three-phase, four wire.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance for Sensitive Loads:
   1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
      a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
   2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
   3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
   4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
   5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
   6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Start Time: Comply with NFPA 110, Type 10, system requirements.
10. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
    a. Provide permanent magnet excitation for power source to voltage regulator.

2.04 ENGINES

A. Fuel: Fuel Oil, Grade DF-2.
B. Rated Engine Speed: 1800 rpm.
C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
D. Lubrication System: The following items are mounted on engine or skid:
    1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
    2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
    3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
E. Engine Fuel System:
    1. Fuel: Fuel oil, Grade DF-2.
    2. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow starting and load conditions.
    3. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
G. Governor: Adjustable Isochronous, with speed sensing.
H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
    1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer. Fill to -40 degrees F.
    2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
    3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
    4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
    5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
        a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and non-collapsible under vacuum.
        b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
I. Silencer: Critical silence type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
    1. Minimum sound attenuation of 18 dB at 500 Hz.
    2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 75 dBA or less.
    3. Provide with stainless steel fittings, flanges, and flexible piping connected to exhaust.

J. Rain cap: Furnish flapper type rain cap for installation at combustion exhaust vent termination. Installation of rain cap by Div. 23.
K. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
L. Starting System: 24V electric, with negative ground.
    1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
    2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
    3. Cranking Cycle: As required by NFPA 110 for system level specified. (10 seconds).
    4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
    5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
    6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
    7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
    8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
        a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
        b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
        c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
        d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
        e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
        f. Enclosure and Mounting: Weatherproof outdoor as indicated herein.

2.05 FUEL OIL STORAGE

A. Comply with NFPA 30.
B. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
    1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
        a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
        b. 5 gallon spill containment box with lockable hinged cover.
        c. Fuel alarm panel with audio and visual alarm.
            1) NEMA 4X enclosure,
            2) Push button to test entire system (electronics and sensors).
            3) Power indicator light.
            4) Audible alarm silence button.
            5) One normally open relay with high level sensor set at 90% fill level.

2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 48 hours' operation at 100 percent of rated power output of engine-generator system without being refilled. Fill to capacity on Project completion.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine. Size to pump fuel from remote fuel oil storage tank located in same room. Refer to drawings.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.

C. Provide raised platform with access stairs as required to allow maintenance of unit. Platform to only be at control panel/circuit breaker location.

2.06 UNIT MOUNTED CONTROL AND MONITORING PANELS

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one of more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched in the 'on' position, generator set starts. The 'off' position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel mounted.
1. Wall-Mounted Cabinet Construction: Rigid-self-supporting steel unit complying with NEMA ICS6. Power bus shall be copper. Comply with UL 891.

C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage / timer.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es) with 'off' position.
9. Generator-voltage adjusting rheostat.
10. Generator overload.
11. Crank cycle.
12. Lamp test button(s)

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated. Coordinate with automatic transfer switch requirements and include all power and control wiring in conduit between generators and transfer switches.
1. Provide additional control wiring to load shed equipment automatic transfer switch(es) during generator overload.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 23 Section "Building Automation System." Provide conduit to BAS for monitoring purposes. Coordinate with Division 23 installers.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
   1. Overcrank shutdown.
   2. Coolant low-temperature alarm.
   3. Control switch not in auto position.
   4. Battery-charger malfunction alarm.
   5. Battery low-voltage alarm.

G. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
   1. Engine high-temperature shutdown.
   2. Lube-oil, low-pressure shutdown.
   3. Over-speed shutdown.
   4. Remote emergency-stop shutdown.
   5. Engine high-temperature pre-alarm.
   6. Lube-oil, low-pressure pre-alarm.
   7. Low coolant level.
   8. Over-current alarm.
   9. Main Circuit Breaker in ‘off’ position.
   10. Ground Fault Alarm.
   11. Test switches and lamp tests.

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are flush-mounted. Locate in per drawings.

I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation and be weatherprooof.

J. Generator Control Wiring Integrity – Provide continuous monitoring of generator control wiring. Loss of remote start signal for any below equipment shall initiate visual and audible annunciations of generator malfunction at the local and remote annunciator(s) and start the generator(s). Provide Asco 5101 Engine Start Circuit Monitor or equal. Provide all associated wiring.
   1. All Automatic Transfer Switches.

2.07 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breakers: Molded-case, electronic-trip type(s); 100 percent rated; complying with UL 489.
   1. Tripping Characteristic: Designed specifically for generator protection.
   2. Trip Rating: Matched to generator rating.
   3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
   4. Mounting: Adjacent to or integrated with control and monitoring panel.
   5. Coordinated with Service Switchgear.

B. Refer to drawings for generator location.

2.08 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
F. Enclosure: Exterior weather-proof enclosure.
G. Instrument Transformers: Mounted within generator enclosure (when not installed in control and power panel)..
H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
    1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
K. Sub-transient Reactance: 12 percent, maximum.
L. Refer to drawings for indicated generator voltage, KW/KVA load size, and output circuit breaker sizes specified.

2.09 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof galvanized steel clad housing, wind resistant up to 100 mph, with heated, non-walk in enclosure, set on concrete foundation.
    1. Construction: Vandal-resistant, weatherproof, Galvanized –steel, clad, integral structural-steel-framed building erected on concrete foundation.
    2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads at the installation location.
    3. Space Heater: Thermostatically controlled and sized to maintain a minimum space temperature of 45F.
    4. Hinged Doors: With padlocking provisions.
    5. Ventilation: Motorized Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents. Thermostatically controlled.
    6. Thermal Insulation: Manufacturer’s standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
    7. Silencer Location: Within Enclosure.
B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
    1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
    2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
C. Interior AC Lights with Switch:Factory-wired, vaporproof-type fixtures within housing; with 30 foot candles average maintained on the controls and accessible interior. Connect to load center installed inside of enclosure.
D. Convenience Outlets: Factory wired, GFCI. Connect to load center installed inside of enclosure.
E. Load Center:
    1. Requirements:
        a. Mounted inside the enclosure.
        b. 120/128-1O-3W.
        c. Main Breaker.
        d. Sized to serve the following loads:
            1) Lights and receptacles.
            2) Jacket heaters.
            3) Battery charger.

4) Enclosure space heater.
5) Battery blanket heater.
6) Motorized louvers.

2. Connect to feeder source inside the building as indicated on the Drawings.

2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Material: Standard neoprene.
2. Durometer Rating: 30.
3. Number of Layers: Two.
4. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
b. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

2.13 TEMPORARY GENERATOR

A. Provide a temporary generator and switchboard as required to provide backup power to the existing facility during period where existing generator/switchboard is disconnected and new equipment is fully operational. Provide 500kW 208V generator or as required to backup entire building load. Provide belly tank with 24-hours of fuel. Provide initial fill of fuel tank to capacity. Provide delivery and connections as required.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Engine generators shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

3.02 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Verify and provide structural support bars, and thickness and size of concrete base required by manufacturer of genset.

D. Combustion exhaust piping and roof/wall thimble provided by Div. 23. Th silencer, flexible pipe connectors, and rain cap furnished under this specification section shall be turned over to the Div. 23 contractor for installation.

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Provide all interconnection and control wiring in conduit between genset and all automatic transfer switches and remote alarm, control and/or monitoring and annunciator panels. Verify wire quantities and types with manufacturer(s) of alarm or monitoring panels.

F. Connect generator dampers, fuel pump motors and associated electrically operated items on emergency power circuits where required for generator operation.

G. Provide full tank of fuel after testing is complete

3.04 CONNECTIONS

A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

3.06 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
      a. Testing shall include demonstration of all operational requirements, including open and closed transition switching as applicable at light (quarter-load), medium (half-load) and full load. Testing shall also include four consecutive hours of operation at full load.
   3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
      b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of the battery after discharge.
      c. Verify that measurements are within manufacturer's specifications.
   4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
   5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
   6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
   7. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
   8. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
E. Coordinate tests with tests for switchgear and with transfer switches and run them concurrently.
F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

M. Include all testing reports in Operation, Maintenance, and Warranty Data Manual(s).

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Provide video taping of this session. Refer to Division 01 Section "Demonstration and Training." Provide an 8 hour training session for Owner personnel.

END OF SECTION 26 32 13

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing of automatic transfer switches of the type and operating characteristics described hereinafter, completely installed, tested, and operative. All necessary equipment, labor, and materials shall be included; the coordination of all required equipment and material shall be the responsibility of one manufacturer, who has had an approved experience record in furnishing similar equipment. The automatic transfer switches shall be closed transition four pole type. The amperage, voltage, withstand, and close-on ratings shall be as shown on the plans.

B. All system equipment, materials, and components shall be of current production models and types, produced and marketed by manufacturers having an established reputation for satisfactory product performance and reliability.

C. The automatic transfer switches shall be used for a Level 1 emergency power supply system. Coordinate and provide all requirements with utility.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for each type of packaged transfer switch indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

B. Qualification Data: For manufacturer.

C. Field quality-control test reports.

D. Operation, Maintenance, and Warranty Data: For each type of product to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance, and Warranty Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.03 QUALITY ASSURANCE

A. Manufacturer of transfer switches shall be specialized in the manufacture and assembly of such equipment for a minimum of 25 years.

B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.

C. Installer Qualifications:

1. An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.

D. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification for 365 days per year.

E. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Comply with NFPA 70, 99, and 110.
H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.04 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. NEMA ICS1 – Industrial Control and Systems.
   2. NEMA ICB-10-1993.
   3. NFPA 110 – Standard for Emergency and Standby Power Systems.
   4. UL 1008 – Transfer Switch Equipment.
   5. IEC 947-6-1.
   6. IEEE Standard 446.

1.05 MAINTENANCE

A. Transfer switch manufacturer / vendor shall:
   1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
   2. Make new replacement parts available for minimum of ten years from date of manufacture.
   3. Provide factory direct technical support hotline 24 hours per day, 7 days per week.
   4. Provide on-site service support within 24 hours anywhere in continental United States.
   5. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.
   6. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.06 COORDINATION

A. Coordinate size and location of transfer switches. Coordinate layout and installation of transfer switch with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Mount on concrete pads where indicated. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of transfer switch(es) and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory’s label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide Automatic Transfer Switches by one of the following:
   1. Emerson; ASCO Power Technologies, LP.
   2. GE Zenith Controls.

2.03 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
   1. Refer to drawings for indicated ampere and voltage ratings.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated 65,000 A.I.C, based on testing according to UL 1008.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts. Inspection of contacts shall be possible without removing or disconnecting of conductors.

G. Neutrals:

1. Where four-pole switches are indicated provide overlapping closed-transition neutral poles switched simultaneously with phase poles.

H. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device. Include all controls and wiring to equipment in conduit as required.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

1. Front access only. Rear and side access not allowed.

2.04 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.

3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
    a. Initiation occurs without active control of generator.
    b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
4. Failure of power source serving load initiates automatic break-before-make transfer.

F. Automatic Transfer-Switch Features:
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Over-Voltage Sensing: 120 percent pick-up; 110 percent dropout.
3. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
4. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator.
    a. Pickup voltage shall be adjustable from 85 to 100 percent of nominal; factory set for pickup at 90 percent.
    b. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
6. Test Switch: Simulate normal-source failure.
7. Switch-Position Pilot Lights: Indicate source to which load is connected.
8. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
9. Auxiliary Contacts: Unassigned: Two (minimum) normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac. Assigned: As required for remote annunciation and control wiring in conduit to remove equipment as required.
10. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
11. Engine Starting Controls: One isolated and normally closed, and one isolated and normally open; rated 10A min. at 32-Vdc minimum.
12. Engine Shutdown Contacts: Time-delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

14. Load Shed Relay (LSR) Feature for Optional Branch ATS: Provide required auxiliary contacts and interface optional branch ATS with load shed relay being provided on the output of the generator such that the “Optional” branch ATS is de-energized under a Generator Overload condition. (ASCO option 30A or equal.)
15. Additional Operational Controls and Contacts: Provide (includes but not limited to) as follows:
    a. Test Switch for “test,” “automatic,” and “reset.” Label as required.
    b. Adjustable time-delay for transferring to “emergency” and to “normal.”
    c. Adjustable time-delay for engine cool down.
    d. Manual bypass button to allow bypass of time-delay back to normal power.
    e. Engine start adjustable time-delay.
    f. AC metering for amperes, voltage, frequency, running time, KVA/PF loads on each side.
16. Interconnection Accessories:
    a. 62PL: Extended parallel condition indicator with alarm.
    b. 86A: Lock-out Relay with Manual Reset. Output contacts rated 3A/125VAC. Relay will trip and lock out other devices such as circuit breaker with a fault or other predetermined condition exists.
    c. Tech Bundle (ASCO 150A):
        1) 5210 Power Meter monitoring Load Side. Provides KW, KVAR, PF and Energy information.
        2) Ethernet Communications Module – Quad-Ethernet.
        3) Power ride through – 25 seconds minimum via internal buffer module.
        4) Provisions for customer supplied 24VDC backup power.

2.05 BYPASS/ISOLATION SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources without any interruption to the load. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
    1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
    2. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
    3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
    4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
    5. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
    6. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions. Provide indicating lights to show bypass isolation switch positions.
    7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper

2.06 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

2.07 CONCRETE BASES

A. Equipment Mounting (where floor-mounting is required): Install on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section.
   1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported unit. Chamfer top edge and corners of pad.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to transfer switch.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Transfer switches shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

C. Mount on 4” concrete bases where floor mounting is indicated.

3.02 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting transfer switch performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before transfer switch installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Comply with transfer switch manufacturers' written installation and alignment instructions and with NFPA 110. Verify / coordinate generator manufacturers' written installation and alignment instructions.

B. Identify components according to Division 26 Section "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.04 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections per requirements below. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Include all test results in Owner’s Operation, Maintenance, and Warranty Data manuals.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training." Include up to 4 hours training.

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

SECTION 26 36 50
PORTABLE GENERATOR DOCKING STATIONS

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing of a portable generator docking station as described herein. The amperage, voltage, withstand, and close-on ratings shall be as shown on the plans.

B. All system equipment, materials, and components shall be of current production models and types, produced and marketed by manufacturers having an established reputation for satisfactory product performance and reliability.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted for each docking station. Include rated capacities, operating characteristics, interconnection diagrams, and furnished specialties and accessories. In addition, include the following:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Single-Line Diagram: Show connections between generator and transfer switches; and show interlocking provisions.

B. Qualification Data: For manufacturer.

C. Field quality-control test reports.

D. Operation, Maintenance, and Warranty Data: For each type of product to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation, Maintenance, and Warranty Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.03 QUALITY ASSURANCE

A. Manufacturer of docking stations shall be specialized in the manufacture and assembly of such equipment for a minimum of 10 years.

B. Equipment shall be listed and/or classified by Underwriters Laboratories and in accordance with standards listed in this Specification.

C. Installer Qualifications:

1. An employer of workers qualified as defined in NEMA PB 1.1 and trained in electrical safety as required by NFPA 70E.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.

D. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification for 365 days per year..

E. Source Limitations: Obtain docking stations through one source from a single manufacturer.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Comply with NFPA 70, 99, and 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.04 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: -20F to 100F.
2. Altitude: Sea level to 1000 feet.

3. Do not deliver or install interior engine-generator sets until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above engine-generators is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Architect, Construction Manager, and Owner no fewer than two weeks in advance of proposed interruption of service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without written permission from Architect, Construction Manager and Owner.

1.05 REFERENCES

A. The products provided by this section shall comply with the following applicable references (latest edition):
   1. NEMA ICS1 – Industrial Control and Systems.
   2. NEMA ICB-10-1993.
   3. NFPA 110 – Standard for Emergency and Standby Power Systems.
   4. UL 1008 – Transfer Switch Equipment.
   5. IEC 947-6-1.
   6. IEEE Standard 446.

1.06 MAINTENANCE

A. Docking station manufacturer / vendor shall:
   1. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
   2. Make new replacement parts available for minimum of ten years from date of manufacture.
   3. Provide on-site service support within 24 hours anywhere in continental United States.

1.07 COORDINATION

A. Coordinate size and location of docking stations. Coordinate layout and installation of docking stations with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Mount on concrete pads where indicated. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide docking station by one of the following:
   1. American Midwest Power
   2. EMI
   3. ESL Power Systems
   4. FoxFab
   5. States Manufacturing
   6. Trystar
   7. Approved Equal.

2.03 GENERAL DOCKING STATION REQUIREMENTS

A. Generator docking stations shall be UL listed and shall consist of cam-style male connectors and grounding terminals, all housed within a pad lockable enclosure.
   1. Enclosure shall be NEMA 3R, constructed of 12 ga galvanealed steel. Enclosure shall be powder coated after fabrication; color shall be ANSI 61 gray.
   2. Phase and neutral bussing: Ampacity as indicated on plan, silver plated copper.
   3. Voltage to match generator output.
   4. Withstand rating: 65kA.
   5. Provide LSI electronic trip breakers:
      a. For temp generator/load bank: Ampacity as indicated on plan.
      b. For life safety breaker: Ampacity as indicated on plan. Provide barrier as required to completely isolate breaker.
   6. Concrete pad mounted.
   7. Main access shall be through hinged door which extends the full height of the enclosure. Access for portable generator cables with female cam-style plugs shall be via hinged lower door. All doors to have 3-point pad-lockable handles.
   8. Cam-style male connectors shall be UL listed. Connectors shall be color coded to match facility voltage colors. Connectors shall be provided for each phase, ground, and neutral. Provide size and quantities of mechanical lug connections required for specified amperage. Not be less than (2) 500 MCM per phase.
   9. The ground connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor. None of the cam-style male connectors shall be accessible unless the main access door is open.
   10. Phase rotation monitor.
      a. L1-L2-L3 indicator lights. Solid green light indicates correct phase rotation. Flashing red light indicates incorrect phase rotation. Solid red indicates phase loss.
      b. 1A time delay fusing for each light.
   11. Generator signal terminal wiring block and contacts.
   12. Selector switch.
      a. Interlocked with permanent generator output breaker. When selector switch is turned to temp generator, the output breaker of permanent generator is to open.
   13. Shore power: (1) 50A 208V and (2) 20A 120V receptacles.
   14. Kirk key interlock between portable generator and permanent generator.

2.04 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation.

2.05 CONCRETE BASES

A. Equipment Mounting (where floor-mounting is required): Install on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section.
   1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported unit. Chamfer top edge and corners of pad.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to transfer switch.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Docking stations shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

C. Mount on 4” concrete bases where floor mounting is indicated.

3.02 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting transfer switch performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before transfer switch installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Comply with manufacturers' written installation and alignment instructions and with NFPA 110. Verify / coordinate generator and transfer switch manufacturers' written installation and alignment instructions.

B. Identify components according to Division 26 Section "Identification for Electrical Systems."

3.04 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of generator and transfer switches as recommended by manufacturer. Increase raceway sizes as required to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Furnish temporary portable generator and provide tests and inspections and prepare test reports.

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. After energizing circuits, demonstrate interlocking sequence and operational function of circuit breakers.

B. Coordinate tests with tests of generator and transfer switch equipment and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Remove and replace malfunctioning units and retest as specified above.

E. Include all test results in Owner’s Operation, Maintenance, and Warranty Data manuals.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training." Include up to 4 hours training.

B. Coordinate this training with that for generator and transfer switch equipment.

END OF SECTION 26 36 50

SECTION 26 43 13
SURGE PROTECTION DEVICES

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installing of surge protective devices (SPD) for the protection of all AC electrical circuits as shown and specified herein.
   1. Switchboard Suppressors.
   2. Panelboard Suppressors.

1.02 DEFINITIONS

A. VPR: Voltage Protection Rating.
B. SPD: Surge Protection Device(s).
C. I(N): Nominal Discharge Current.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
B. Product Certificates: For SPDs, signed by product manufacturer certifying compliance with the following standards:
   1. UL 1283.
   2. UL 1449 latest edition.

1.04 CLOSEOUT SUBMITTALS

A. Field quality-control test reports, including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.
B. Operation and Maintenance Data:
   1. For SPDs to include in emergency, operation, and maintenance manuals.
   2. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Submit record of transmittal as part of O&M Manual. Refer to “Extra Materials” article in Part 2 below.
   3. Include field quality control reports and warranty information.
C. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
D. Comply with NFPA 70.
E. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Surge Protective Devices."

1.06 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect/Engineer not less than ten days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect/Engineer's written permission.

B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
   1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage for 480/277Y and not less than 125 percent of nominal system operating voltage for 208/120Y.
   2. Operating Temperature: 30 to 150 deg F (0 to 60 deg C).
   3. Humidity: 0 to 95 percent, noncondensing.
   4. Altitude: Less than 12,000 feet above sea level.

1.07 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products for the service entrance and panelboard SPDs by one of the following:
   1. Cutler-Hammer, Inc.; Eaton Corporation.
   2. General Electric Company.
   3. Siemens Energy & Automation, Inc.
   4. Square D; Schneider Electric.

2.02 SWITCHBOARD SUPPRESSORS

A. Surge Protection Device Description: Service entrance SPDs shall be field-mounted, external to the power distribution equipment.

B. Surge Protective Devices shall be:
   1. UL 1449 Listed TYPE 2.
   2. Fuses, rated at 200-kA interrupting capacity.
   3. Minimum UL 1449 withstand (In) rating to be 20kA per mode.
   4. Bolted compression lugs for internal wiring.
   5. Redundant suppression circuits.
   6. Replaceable modules, 1 per phase minimum.
   7. LED indicator lights for power and protection status.
   8. Audible alarm, with silencing switch, to indicate when protection has failed.
   9. Form-C contacts rated at 2 A and 24-V ac minimum, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   10. Six-digit transient-event counter set to totalize transient surges.
   11. Enclosure: same as switchboard.

C. Peak Single-Impulse Surge Current Ratings to be selected by environment:

Category/Type	Application	Per Phase	Per Mode
C Type 2	Service Entrance	240 kA	120 kA
B Type 2	High Exposure Locations (Distribution Equipment)	160 kA	80 kA

D. The ANSI/UL 1449 voltage protection rating (VPR) in grounded wye circuits, the SPDs shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N, L-G, N-G	800	1200	1500
L-L	1200	2000	2500

E. The ANSI/UL 1449 VPR for 240/120 V, 3-wire or 4-wire circuits with high leg shall not exceed the following:

Modes	240/120
L-N, L-G, N-G	1200/800

2.03 PANELBOARD SUPPRESSORS

A. Surge Protection Device Description: Service entrance SPDs shall be factory mounted, within the power distribution equipment.

B. Surge Protective Devices shall be:

1. UL 1449 Listed TYPE 2.
2. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with fused metal-oxide varistors.
3. Fuses, rated at 200-kA interrupting capacity.
4. Minimum UL 1449 withstand (In) rating to be 20kA per mode.
5. Fabrication using bolted compression lugs for internal wiring.
6. Replaceable modules.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. Form-C contacts rated at 2 A and 24-V ac minimum, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
11. Six-digit transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating:

Category/Type	Application	Per Phase	Per Mode
B Type 2	High Exposure Locations (Distribution Equipment)	160kA	80kA
B Type 2	Branch Locations	120kA	60kA

D. The ANI/UL 1449 voltage protection rating (VPR) in grounded wye circuits, the SPDs shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N, L-G, N-G	800	1200	1500
B Type 2	1200	2000	2500

E. The ANSI/UL 1449 VPR for 240/120 V, 3-wire or 4-wire circuits with high leg shall not exceed the following:

Modes	240/120
L-N, L-G, N-G	1200/800

PART 3 EXECUTION

3.01 INSTALLATION

A. Install switchboard SPDs per manufacturer's recommendations with buses or low-impedance conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length.

B. Provide 60 Amp overcurrent protection device within switchboard as a dedicated disconnecting means for SPD unless otherwise indicated.

3.02 FIELD QUALITY CONTROL

A. Ensure that interiors are free of foreign materials and dirt.

B. Check and test switches, pushbuttons, meters for proper operation.

C. Check and test indicating lights for proper operation and color.

D. Perform manufacturers on site field test procedures.

3.03 STARTUP SERVICE

A. Do not perform insulation resistance (MEGGER) tests of the distribution wiring equipment with the SPDs installed. Disconnect all wires, including neutral, before conducting insulation resistance tests, and reconnect immediately after the testing is over.

END OF SECTION 26 43 13

SECTION 26 51 00
LIGHTING

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installing of luminaires as shown and specified herein complete with lamps, supporting devices, and other appurtenances as required.
   1. Luminaires.
   2. LED systems.
   3. Exit and Emergency systems.
   4. Luminaire supports.
   5. Poles, pole supports and pole accessories.
   6. Lighting rebate forms.

1.02 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color-rendering index.
C. LER: Luminaire efficacy rating.
D. Lumen: Measured output of luminaire.
E. Luminaire: Complete lighting fixture, including driver housing if provided.

1.03 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
B. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
   1. Basic wind speed for calculating wind load for poles is per AASHTO LTS-4-M. Wind Importance and Velocity Conversion Factors shall be per Table 3-2. Minimum Design Life shall be per Table 3-3.

1.04 SUBMITTALS

A. Product Data: For each type of luminaire, pole and support component, arranged in order of luminaire designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire including dimensions.
   2. Rated life, lumen output, energy, and efficiency data for LED components.
   3. Materials, dimensions and finishes of poles.
   4. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
   5. Manufactured pole foundations.
   6. Anchor bolts for poles.
   7. Photometric data, in IESNA format, based on laboratory tests of each luminaire type, outfitted with lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project. For indicated fixtures photometric data shall be certified by a qualified independent testing agency, photometric data for remaining fixtures shall be certified by manufacturer.
   8. Installation instructions.
B. Shop Drawings: Show details of nonstandard or custom luminaires. Indicate plans, elevations, sections, details and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: Power, signal and and control wiring.
C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

D. Operation, Maintenance and Warranty Data:
   1. For lighting equipment and luminaires to include in emergency, operation, maintenance and warranty data manuals.
   2. Special warranties specified in Part 3 of this Section.
E. Product Certificates: For each type of dimming driver and associated dimmer controller, from luminaire manufacturer.
F. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Lighting Rebates: Copy of completed lighting rebate forms, including all backup information and receipts.
B. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   1. Provide record of rebate forms as part of O&M Manual. Refer to "Rebate Forms" in Part 2 below.
   2. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Submit record of transmittal as part of O&M Manual. Refer to "Extra Materials" article in Part 2 below.
   3. Submit record of warranty as part of O&M Manual. Refer to "Warranty" article in Part 1 below.

1.06 SUBSTITUTIONS

A. Type, grade, quality and photometric data of luminaires are indicated on the Luminaire Schedules on the drawings by manufacturers' specified Catalog Numbers. Substituted luminaires including outdoor luminaires, may be required to provide "Point-By-Point" layouts. Substituted luminaire manufacturers may require additional luminaires.
B. Luminaires not listed on the schedule shall require submittal for prior approval. Coordinate exact requirements with Engineer.
C. All submittals for parking lot luminaires must contain calculations showing maintained horizontal footcandle levels in the parking lot, complete with all light loss factor assumptions.

1.07 QUALITY ASSURANCE

A. The equipment manufacturer shall be regularly engaged in manufacture of luminaires, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than ten years.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
D. The products provided by this section shall comply with the following applicable references (latest edition):
   1. ANSI C82.SSL1: SSL Drivers
   2. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
   3. IES-LM-79: LED Luminaires – Electrical and Photometric Measurements of Solid-State Lighting Products.
   4. IES-LM-80: LED Luminaires – Measuring Lumen Maintenance of LED Light Sources.
   5. IES-TM-21: LED Luminaires – Projection of LED Life.
   6. NEMA LE 4: Recessed Luminaires.
   7. NSF: Lighting fixtures for use in commercial kitchens shall be listed and labeled suitable for such use per National Sanitation Foundation standards.
   8. UL 924: Emergency Lighting and Power Equipment.
   9. UL 1598: Luminaires.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.09 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including but not limited to structural members, HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

A. Special Warranty for LED Fixtures: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace LED and driver components, or fixture in its entirety, that either partially or entirely fails in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 5 years from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for three years, and prorated warranty for the remaining seven years.

C. Special Warranty for Exterior Luminaires, Poles and Accessories: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

D. Provide documentation of warranties in O&M Manual.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory’s label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards. Provide quick disconnects for light luminaires for wiring as required by Code.

B. Where screw-in LED lamps are indicated on drawings and schedules provide luminaires with lamps for each outlet as required.

C. The type luminaires required are as noted by a capital letter on the Drawings. Contractor shall be solely responsible for the exact quantities. Any outlets not specifically noted on the Drawings shall be equipped with luminaires similar to those in rooms used for like purposes.

2.02 MANUFACTURERS

A. Products: subject to compliance with requirements below, provide products as indicated on the Drawings.

2.03 LUMINAIRES AND COMPONENTS, GENERAL REQUIREMENTS

A. Doors, Frames, and Other Internal Access:
   1. Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools unless otherwise noted. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.
   2. Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

B. Metal Parts: Free of burrs and sharp corners and edges. Sheet metal shall be steel, unless otherwise indicated, and formed and supported to prevent warping and sagging.

C. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metallized Film: 90 percent.

D. Plastic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation. Minimum lens thickness shall be .125 inch. UV stabilized.
   2. Glass: Annealed crystal glass, unless otherwise indicated.

E. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

F. Provide UL fire rated enclosure as required for luminaires installed in a rated ceiling if luminaires are not fire rated.

G. Lighting fixtures shall have a specific means for grounding metallic wire-ways and housings to an equipment grounding conductor.

H. Where color temperatures specified within this section differ from temperatures specified on plans the contractor shall obtain explicit verification of color temperature from engineer prior to ordering.

I. Additional Requirements for Exterior Luminaires:
   1. Exposed Hardware Material: Stainless steel.
   2. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   3. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
   4. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
   5. Luminaire-Mounted Photoelectric Relays (where indicated):
      a. Comply with UL 773 or UL 773A.
      b. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff
         1) Relay with locking-type receptacle shall comply with ANSI C136.10.
         2) Adjustable window slide for adjusting on-off set points.
   6. Luminaire Finish:
      a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, “Solvent Cleaning,” to remove dirt, oil, grease and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, “White Metal Blast Cleaning,” or SSPC-SP 8, “Pickling.”

b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    1) Color: If not specifically indicated on plans, finish and color shall be as selected by Architect.

2.04 LED SYSTEMS

A. Provide driver as required for proper operation of fixture:
1. The driver's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design.
2. The use of fans or other mechanical devices is prohibited.

B. Technical requirements:
1. Fixtures shall be tested and rated per most recent edition of IES LM-79, IES LM-80, and IES TM-21 with rated life of 70,000 hours or greater.
    a. Assume each luminaire will operate at an average operating time of twelve hours per day.
    b. Each luminaire is expected to have a minimal operational life of 120 months (ten years).
2. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to ensure proper operation of the luminaire over the rated life.
    a. The maximum junction temperature for the rated life shall not be exceeded at the average operating ambient.
    b. The maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.
3. The individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
4. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages.
5. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage.
6. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference.
    a. The surge protection which may reside within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 for Location Category A Low. Where failure does not mean a momentary loss of light during the transient event.
    b. Surge protection performance shall be tested per the procedures in ANSI/IEEE C62.45 based on ANSI/IEEE C62.41 definitions for standard and optional waveforms for Location Category A-Low.
7. Operational Performance: The LED circuitry shall prevent perceptible flicker to the unaided eye over the voltage range specified above.
8. RF Interference: The luminaire and associated onboard circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
9. Dimming (where indicated): The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100% to 5% of rated lumen output. Dimming shall be controlled by a 0-10V signal.
10. Lumen Management (where indicated): The luminaire shall be capable of continuously monitoring system performance to allow for constant lumen management / compensation function.
11. Output Color:
    a. Interior Fixtures: Minimum CRI 80, and color temperature 4100 K (+/- 100K) unless noted otherwise.
    b. Exterior Fixtures: Minimum CRI 70, and color temperature 4100 K (+/- 100K) unless noted otherwise.

12. Operating temperature (exterior and cold-weather interior fixtures only)
    a. The operating temperature range shall be 40°F to +130°F.
    b. Each luminaire shall be designed to operate at an average nighttime operating temperature of 70°F.
    c. Each luminaire is expected to operate at a daytime ambient temperature of 104°F, and to comply with photometric requirements.
    d. Parameters and tests (such as IES-LM-79, IES-LM-80and IES-TM-21) shall be conducted at 104°F ambient temperatures.
    e. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime operating temperature.

C. Protective Requirements for LED Systems in Pool Environments:
    1. Provide coating on LED boards to prevent typical pool chemicals from breaking down LED emitters.
    2. Provide gasketing to prevent off-gassing.

D. Housing for Exterior LED Systems:
    1. The assembly and manufacturing process shall be designed to ensure all internal components are adequately supported to withstand mechanical shock and vibration.
    2. The electronics/power supply enclosure shall be internal to the luminaire and be accessible per UL requirements.
    3. The assembly and manufacturing process shall be designed to ensure all internal components are adequately supported to withstand mechanical shock and vibration from winds and other sources.
    4. The housing shall be designed to prevent the build-up of water on the top of the housing. Exposed heat sink fins shall be oriented so that water can freely run off the luminaire, and carry dust and other accumulated debris away from the unit.
    5. The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-65 (minimum) to protect all internal components.
    6. The electronics/power supply enclosure shall be protected per the requirements of IP-43 (minimum).
    7. When the components are mounted on a down opening door, the door shall be hinged and secured to the luminaire housing separately from the refractor or lens frame. The door shall be secured to the housing in a manner to prevent its accidental opening. A safety cable shall mechanically connect the door to the housing.

2.05 EXIT SIGNS AND EMERGENCY LIGHTING SYSTEMS

A. Exit Signs:
    1. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
    2. Internally Lighted Signs:
        a. Universal voltage.
        b. Lamps for AC operation: LED, 50,000 hours minimum rated lamp life.
        c. Provide self-powered signs unless specifically noted on plans that signs are fed from external emergency power source and not required to contain internal batteries.
        d. Self-Powered Exit Signs / Battery Type: Integral automatic charger in a self-contained power pack.
            1) Battery: Sealed, maintenance-free, nickel-cadmium type.
            2) Charger: Fully automatic, solid-state type with sealed transfer relay.
            3) Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
            4) Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

5) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6) Remote Test (where indicated): Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7) Integral Self-Test (where indicated): Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

B. Emergency Lighting Units (standalone battery wall packs):
1. Description: Self-contained units complying with UL 924.
a. Battery: Sealed, maintenance-free, lead-acid type.
b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Wire Guard (where indicated): Heavy-chrome-plated wire guard protects lamp heads or luminaires.
g. Integral Time-Delay Relay (where indicated): Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
h. Remote Test (where indicated): Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
i. Integral Self-Test (where indicated): Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

C. Integral Emergency Power Unit (battery integral to fixture):
1. Manufacturers: Bodine B50ST, IOTA, or approved equal.
2. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast. Comply with UL 924.
a. Emergency Connection: Operate luminaire continuously at 100% output. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire driver.
b. Night-Light Connection: Operate luminaire continuously at 100% output.
c. Test Push Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
1) Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
2) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
d. Battery: Sealed, maintenance-free, nickel-cadmium type.
e. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
f. Remote Test (where indicated): Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. Integral Self-Test (where indicated): Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

D. Battery Inverter (remote battery):
1. Description: Inverter sized to feed LED fixture.
a. Battery: Sealed, maintenance-free, lead-acid type.
b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. Operation: Relay automatically turns fixture on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Fixture automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects fixture from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Integral Time-Delay Relay (where indicated): Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
g. Remote Test (where indicated): Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
h. Integral Self-Test (where indicated): Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.06 LUMINAIRE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.
D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
E. Wires for Humid Spaces (where indicated): ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
G. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.07 POLES, POLE SUPPORTS AND POLE ACCESSORIES

A. General Requirements for Poles and Support Components:
1. Structural Characteristics: Comply with AASHTO LTS-4-M.
a. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
b. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
2. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
    a. Materials: Shall not cause galvanic action at contact points.
    b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
    c. Anchor-Bolt Template: Plywood or steel.
4. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
5. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 and 32 (as applicable). Strength to be minimum of 4,500 psi.
6. All poles greater than 15' shall be provided with a factory installed vibration dampening device.
7. Shape, height and material as specified on plans:
    a. SSS = Straight, square, steel
    b. SRS = Straight, round, steel
    c. TSS = Tapered, square, steel
    d. TRS = Tapered, round, steel
    e. SSA = Straight, square, aluminum
    f. SRA = Straight, round, aluminum
    g. TSA = Tapered, square, aluminum
    h. TRA = Tapered, round, aluminum

B. Pole Material:
1. Aluminum Poles:
    a. Provide aluminum poles unless specifically indicated on drawings.
    b. Standard Aluminum: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
    c. High-Strength Aluminum (where indicated): ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
2. Steel Poles (where indicated):
    a. Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

C. Pole Requirements:
1. Shape: Tapered square, or as noted on the plans.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
3. Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.
4. Brackets for Luminaires: Detachable, cantilever, without underbrace.
    a. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
    b. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
    c. Match pole material and finish.
5. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
6. Grounding and Bonding Lugs: Welded ½-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
7. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

8. Factory-Applied Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
    a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
    b. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
    c. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
        1) Color: If not specifically indicated on plans, finish and color shall be as selected by Architect from standard finishes and colors palette. Unless specifically noted, color shall apply to both luminaire and pole.

D. Pole Accessories (where indicated):
1. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.
    a. Surface mounted, 24 inches above finished grade.
    b. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, color to match pole, that when mounted results in NEMA 250, Type 3R enclosure.
    c. With cord opening.
    d. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
    e. Associated minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
2. Holders and Fuses: Provide in base of all outdoor lighting pole units. Fuseholders shall be Buss Type Tron-HEB. Fuses shall be Buss Type KTK, size according to load.
3. Decorative accessories, supplied by decorative pole manufacturer, including banner arms, flag holders and ladder rests.

2.08 LIGHTING REBATE

A. Contractor shall coordinate with the local power company and the Owner as required to obtain all applicable lamp, ballast, and lighting control rebates. Apply the Utility's applicable rebate program to the project.
1. Secure maximum rebate on behalf of the Owner.
2. Complete all forms necessary to secure rebates.
3. All Rebates shall be made directly to the Owner.
4. Provide all invoicing and product information necessary to procure rebate.

B. Provide final copies of completed rebate forms in O&M Manual.

2.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

B. Provide spare fixtures as indicated on luminaire schedule. Include ten feet of branch circuitry and all necessary labor for each fixture. For emergency and exit fixtures connected to generator systems include fifty feet of conduit and wire. Turn over unused spare fixtures to the Owner at the completion of the project.

C. Provide documentation signed by Owner proving transmittal of the above materials from Contractor to Owner. Documentation shall include copy of "Extra Materials" article for reference. Include documentation in O&M Manual.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Luminaires shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Install luminaires at locations and heights as indicated. Set units plumb, square, and level with ceilings and walls and secure in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, with recognized industry practices to ensure that lighting luminaires fulfill requirements, and with Shop Drawings. Support luminaires in accordance with requirements of Section 16050, "Basic Electrical Materials and Methods".

C. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

D. Luminaire types are indicated by a capital letter next to the luminaire. Small letters indicate switching patterns and numbers indicate circuit connection. Any luminaires not typed shall be assumed to be the same as adjacent luminaires or luminaires in like areas in the building.

E. Height and Weight Considerations:

1. Fixture heights are measured from finished floor to bottom of fixture, unless specifically noted otherwise.
2. Where mounting heights are neither shown on electrical plans nor architectural elevations verify exact height with Architect/Engineer prior to rough-in and ordering of fixture.
3. Provide luminaires and/or luminaire outlet boxes with hangers to properly support luminaire weight. If design of hangers or method of fastening, differs from what is indicated or specified herein then submit for review by Architect/Engineer.

F. Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Architect/Engineer.

G. Adjust luminaires that require field adjustment or aiming. Include adjustment of integral photoelectric devices to prevent false operation of relay by artificial light sources, with exterior devices favoring a north orientation.

H. Rectangular and square fixtures surface mounted or mounted in sheetrock, gypsum board, plaster or similar ceilings shall be parallel or perpendicular to the building structure and accurately line up with respect to building elements and each other. If fixtures are not initially installed correctly the Contractor shall be responsible for any and all corrective work required to reinstall fixtures.

I. Daisy-chaining of luminaires is not acceptable. Fixtures shall be whipped directly to junction boxes.

3.02 EXAMINATION / COORDINATION

A. Examine conditions for compliance with lighting luminaire (luminaire) and ambient-temperature requirements for each luminaire.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, soffits, ceilings, floors, roofs, and parapets for suitable mounting conditions where luminaire will be installed.

D. Examine / excavate site for suitable placement conditions for where concrete bases will be installed. Verify with civil and site plans for finish grade, curb, road, sidewalk, etc. locations.

E. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

F. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

3.03 INSTALLATION OF INTERIOR LUMINAIRES

A. Support for Luminaires in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of two ceiling support system rods or wires for each luminaire. Locate not more than 6 inches (150 mm) from luminaire corners.
   2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
   3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
   4. Install flush mounted luminaires to eliminate light leakage between luminaire frame and finished surface.

B. Support for Flush Luminaires in Plaster / Gypsum – Type Suspended Ceilings: Use ceiling as a support element.
   1. Provide plaster frames for recessed luminaires installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
   2. Install flush mounted luminaires to eliminate light leakage between luminaire frame and finished surface.

C. Suspended Luminaire Support:
   1. Fasten luminaires securely to structural supports and ensure that pendant luminaires are plumb and level. Do not support luminaires from the ceiling system. Provide individually mounted pendant luminaires longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum 1" vertical adjustment. Mount continuous rows of luminaires with an additional stem hanger greater than number of luminaires in the row.
   2. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

D. Surface Flush mounted Luminaires:
   1. Support surface mounted luminaires greater than 2 feet in length at a point in addition to the outlet box luminaire stud. At surface mounted luminaires mounted over flush mounted junction box, provide opening through luminaire to junction box for wiring access.

E. Install THHN 90°C wire minimum for wiring entering the ballast chamber such as pendant wiring, whips, flexible cords, or through ballast chambers in continuous row luminaires. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
   1. Connectors: Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.

F. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's instructions.

G. Provide guards for exit light and emergency battery wall pack light luminaires in gymnasiums and where indicated.

3.04 INSTALLATION OF EXTERIOR LUMINAIRES

A. Building-Mounted Exterior Luminaires:
   1. Comply with “Installation of Interior Luminaires” above.
   2. In damp and wet locations seal luminaire infrastructure (i.e. knockouts, pipe and wiring entrances, etc.) as is standard industry practice to prevent water from entering luminaires.

B. Pole Installation:
   1. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

2. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
    a. Fire Hydrants and Storm Drainage Piping: 60 inches.
    b. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
    c. Trees: 15 feet.
3. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 and 32 (as applicable).
4. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
    a. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
    b. Install base covers, unless otherwise indicated.
    c. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
5. Raise and set poles using web fabric slings (not chain or cable).
6. Grounding of Poles:
    a. Ground metal poles and support structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”
        1) Install grounding electrode for each pole, unless otherwise indicated.
        2) Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
    b. Ground nonmetallic poles and support structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”
        1) Install grounding electrode for each pole.
        2) Install grounding conductor and conductor protector.
        3) Ground metallic components of pole accessories and foundations.

C. Bollard Luminaire Installation:
1. Align units for optimum directional alignment of light distribution.
2. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 and 32 (as applicable). Specific bollard-mounting details on plans supersede any conflicting information noted here.

D. Installation Of Individual Ground-Mounting Luminaires
1. Install on concrete base with as shown on drawing detail. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 and 32 (as applicable). Specific ground-mounting details on plans supersede any conflicting information noted here.

E. Corrosion Prevention:
1. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
2. Steel Conduits: Comply with Division 26 Section “Raceway and Boxes for Electrical Systems.” In concrete foundations, wrap conduit with 0.010-inch- (0.254 –mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.05 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components. Replace luminaires that show evidence of corrosion during Project warranty period.

B. Emergency / Egress Lighting Tests: Verify normal power operation of each luminaire after luminaires have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include the following information in tests of emergency lighting equipment:
   1. Duration of supply.
   2. Low battery voltage shutdown.
   3. Normal transfer to battery source and retransfer to normal.
   4. Low supply voltage transfer.

C. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls, either by observation of fixtures being on at night and off during the day, or by simulating darkness by temporarily covering photoelectric controls. Report observations in writing to Architect/Engineer.

D. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.

E. Replace defective and burned out lamps for a period of one year following the Date of Substantial Completion.

F. At Date of Substantial Completion, replace lamps in lighting luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect/Engineer.

G. Refer to Division 1 sections for the replacement/restoration of lamps in lighting luminaires, where used for temporary lighting prior to Date of Substantial Completion.

H. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.06 CLEANING / PROTECTION

A. Clean luminaires of dirt and construction debris after completion of installation. Clean fingerprints and smudges from lenses. Use methods and materials recommended by manufacturer.

B. Protect luminaires before, during and after installation from construction dust and debris.

C. Clean all luminaire surfaces, lenses and/or louvers after completion of construction.

D. Protect installed luminaires from damage during remainder of construction period.

3.07 DEMONSTRATION

A. Upon completion of installation of luminaires, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then re-test to demonstrate compliance; otherwise, remove and replace with new units, and proceed with re-testing.

END OF SECTION 26 51 00

SECTION 26 70 00
RACEWAY FOR LOW VOLTAGE SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. Work under this section includes the furnishing and installation of raceway systems:
   1. For Division 27 and 28 systems, as specified herein and as shown on the drawings.
   2. For systems installed by others (Owner, Owner's vendor, etc.), where rough-in requirements are shown on drawings.
      a. Nurse Call

1.02 RELATED SECTIONS

A. Section 260500 - General Requirements
B. Section 260533 - Raceway and Boxes for Electrical Systems
C. Division 27 and 28.

1.03 COORDINATION

A. Systems as listed within this section are provide by Owner or Owner's vendor complete with devices, racks, head end equipment, and wiring/cables, unless otherwise indicated.
B. Typical conduit sizes and box locations are shown on plans. Coordinate conduit and rough-in requirements and locations with Owner or Owner's vendor for each system prior to rough-in.
C. Coordinate rough-in locations with casework, furniture, openings, door swing, other trades, etc.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Conduit - Refer to Section 26 05 33

2.02 COMMUNICATIONS RACEWAY AND BOXES SYSTEMS

A. Boxes:
   1. Unless noted otherwise, outlet boxes shall be 4" square extra deep galvanized steel with single gang mud ring.
B. Raceway:
   1. Conduit shall be minimum 1" or as sized on drawings.
      a. Provide type EMT where concealed in walls and ceilings or exposed in unfinished spaces.
      b. Provide surface raceway where exposed in finished spaces.
      c. Provide PVC where buried in earth or in concrete.
   2. Conduits shall be concealed wherever possible.

2.03 GENERAL ITEMS

A. Sleeves:
   1. Provide all sleeves necessary for low voltage system installation. Required sleeve paths are not necessarily all shown on plans.
B. Coverplates:
   1. Systems outlets will be equipped with plates provided by the Owner's vendor. Equip all unactivated outlets with blank plates to match specified wiring device plates. Coordinate with Owner's vendor.
C. Backboards:
   1. Provide plywood backboards for systems provided by Owner or Owner's Vendor. Backboards shall be commercial grade 3/4" thick plywood sized as shown on drawings and painted on front and edges with light gray flame retardant enamel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conduits:
   1. Conduits shall be stubbed into the nearest accessible ceiling space. Where accessible ceiling space is not available to provide a cabling path to the point of termination, provide empty conduit or raceway as required or as indicated on plans.

2. Install a maximum of two 90-degree bends or the equivalent for each length of raceway unless Drawings indicate otherwise. Provide bushed ends on all raceway stub-ups.
3. Provide a pull string in each conduit. If conduit is not used during construction, secure each end within raceway system prior to installing the blank coverplate.

B. Sleeves:
1. All openings in firewalls and floors for low voltage cables shall be filled by this contractor with removable fire-retardant material unless openings are fireproofed by low voltage vendor prior to substantial completion of the project. Refer to Section 26 05 33.

C. At least one quadruplex receptacle on a 120V 20A dedicated circuit shall be provided at each low voltage terminal board or cabinet, unless otherwise noted. Verify mounting heights and specific locations with Owner or Owner's vendors prior to installation.

END OF SECTION 26 70 00

SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of common work for communication systems shown on the drawings and specified herein. The omission of express reference to any items or work necessary for, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor from providing such items or work.

B. Scope and Intent:
   1. Demo and Renovation at the Nelson Care Center by Vivie.
   2. This will be a phased project.

C. This section includes:
   1. Communications equipment coordination and installation.
   2. Common communications installation requirements as shown, required, and specified herein.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section shall be used in addition to the Division 26 specifications. Installation methods and material specifications of general wiring, grounding, conduit, hangers and supports shall be governed by Division 26 specifications.

1.03 DEFINITIONS

A. The terms listed below are defined as follows only when used in Division 26, 27, and 28
   1. Work: Labor and materials of the Contractor and/or Sub-contractor
   2. Furnish: Obtain, coordinate, submit the necessary drawings, deliver to the job site in new condition and guarantee
   3. Install: Receive at job site, unload, store, set in place, connect, place in operation and guarantee.
   4. Provide: Furnish and install
   5. Conduit: Includes, in addition to conduit, all fittings, pull; boxes, hangers, and other supports and accessories related to such conduit.
   6. Concealed: Hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, in crawl spaces or buried.
   7. Exposed: Not installed underground nor concealed as defined above.
   8. The building structure or building structural members consist of steel columns, steel beams, steel joists (top chord and at panel points), concrete walls and concrete block walls. Metal decking, joist bridging and bottom chords of bar joists shall not be construed as building structure or as a building structural member for the purpose of support.

B. Division 27 work shall be finished work, tested, and ready for operation.
   1. Cable, equipment, licensure, or any other materials or work not indicated or any incidental accessories necessary to make the work complete and ready for operation, even though not specified nor shown on the drawings, are to be provided, unless otherwise noted.
   2. Should there be any discrepancies or a question of intent, refer the matter to the Architect/Engineer/Designer for a decision before ordering equipment or materials and before starting any related work.
   3. Where work connects to that of another trade, or to wiring or equipment in place, take measurements in the field to make connecting work come true and line up with the item to which is being connected.

1.04 REFERENCES

A. Codes - Materials and workmanship shall comply with the most recently adopted applicable codes. As a minimum, codes include: All State and Federal laws, local ordinances, utility company regulations and requirements and recommendations of the following:
   1. State and Local Building codes
   2. Life Safety Code
   3. International Building Code
   4. State and Local Fire Codes and Regulations
   5. International Fire Code
   6. National Electric Code
   7. State and Local Electrical Codes
   8. Occupational Safety and Health Administration Regulations
   9. If these specifications with accompanying drawings are in any way at variance with these codes, the above cited codes shall govern and the Contractor shall make this installation accordingly, except where the drawings or specifications call for a higher quality of work than required by the Code.

B. Standards - These shall be used where referenced by the following abbreviations:
   1. American Disabilities Act
   2. American Institute of Architects
   3. American National Standards Institute
   4. Building Industry Consulting Service International
   5. Institute of Electrical and Electronic Engineers
   6. National Electrical Contractors Association
   7. National Electrical Manufacturers Association
   8. National Fire Protection Association
   9. Occupational Safety and Health Act
   10. Telecommunication Electronic Industry
   11. Underwriter's Laboratories

1.05 INSPECTION OF SITE BEFORE CONSTRUCTION

A. Before submitting a proposal on the work contemplated, bidder shall examine the site of the proposed work and thoroughly familiarize himself/herself with existing conditions and limitations affecting the performance of their work. No extra compensation will be allowed because of misunderstanding as to the amount of work involved or the bidder's failure to verify existing conditions which they could have discovered or reasonably anticipated prior to bidding. Contractor shall be responsible for any additional cutting, patching, mounting or installation modifications, etc., not called out on the drawings but required for the successful completion of the job.

B. This includes any additional work required due to any existing jobsite condition (i.e., the construction of walls, ceiling spaces, clearances, available voltages, mounting requirements, existing equipment coordination, hazardous materials, etc.) that the contractor had an opportunity to determine in a pre-bid walk-through and could have reasonably determined before the bid by visual inspection or by asking the Engineer or Owner. No additional money shall be awarded for additional work incurred caused by existing jobsite conditions which could have been verified by the contractor prior to bid. In addition, no additional money shall be awarded for failure to properly coordinate with other trades.

1.06 PLAN INTERPRETATION

A. The plans are diagrammatic and indicate the arrangement of systems and equipment unless indicated otherwise by dimensions or detail plans of 1/8" = 1'-0" scale or larger. Refer to dimensioned plans for exact locations of building elements. However, field measurements take precedence over dimensioned plans. Report any differences discovered between electrical plans, systems plans, and the plans for other divisions. The installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings.

B. Equipment outlines shown on detailed plans of 1/8" = 1'-0" scale or larger and/or dimensions indicated on the plans are limiting dimensions. Do not install any equipment that exceeds the equipment outlines shown or reduces indicated clearances.

1.07 PERMITS, LICENSES, AND FEES

A. The Contractor shall secure all permits and licenses, both temporary and permanent required for their work. The Contractor shall pay all fees and expenses required for the permits and licenses.
   1. The Contractor shall make all arrangements with the utility company and pay all service charges associated with new services or modifications to existing services.
   2. The Contractor shall request inspections as required by regulating agencies and/or regulations. The Contractor shall pay all charges for inspections.
   3. Contractor shall furnish the Owner with a certificate of final inspection and approval by enforcement authorities.
   4. Contractor shall register installation of of any Outside Plant cabling with local One Dig authority.
   5. Comply with requirements of Division 00.

1.08 SUBMITTALS

A. Provide the following submittals.
   1. Shop Drawings: Provide for approval of equipment listed in Division 27 sections.
   2. Samples: Provide samples of equipment or system components for examination/approval as requested.
   3. Instructions and Manuals: Provide on-site training and copies of instruction manuals to Owner designated personnel for operation, maintenance and warranty of electrical systems.
   4. Test Reports: Reports shall be submitted outlining the results of testing performed for the installed equipment as described herein.
   5. As-Built / Record Drawings: Keep layout plans for each system on the job site, marking changes made during installation. At completion of the project, submit this set of Record drawings as part of As-Built documents as described herein.
   6. Warranty: Provide warranty information upon project completion.

1.09 QUALITY ASSURANCE

A. Workmanship - All Work on each system complying with these Specifications shall be carried out and/or managed by a competent firm. The respective contractor(s) shall be regularly engaged in the installation and testing of the system that is their responsibility. If requested, the Contractor shall furnish evidence of its qualifications to perform the Work specified. Evidence may be a listing of major lines of equipment for which the Contractor is a dealer. This evidence may also include a list of projects of similar scope, size, and complexity that the Contractor has performed, including names of contacts and phone numbers for each project.

B. The Contractor shall not employ a proposed project manager to whom the Owner or Engineer has made reasonable and timely objection. The Contractor shall not change the project manager without the Owner's consent, which shall not unreasonably be withheld or delayed.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Schedule all deliveries and provide for proper receipt, handling, storage, and protection of materials and equipment used in Work. Owner is not responsible for nor shall be involved in any delivery, storage, or handling of materials or equipment used in Work.

B. Schedule deliveries and provide for proper receipt, handling, storage, and protection of materials and equipment used in Work to prevent damage or deterioration until final acceptance by the Owner.

C. Materials or equipment sustaining damage or deterioration from any cause whatsoever shall be replaced or repaired at the Contractor's expense as directed by the Engineer.

D. Provide written and signed receipts for uninstalled system accessories, materials, and equipment and are provided to the Owner for their own use. Verify that the Owner's representative signing the receipts has responsibility for the materials. Contractor shall be responsible for items that are missing if they cannot provide the signed receipt records for the missing items.

1.11 PROTECTION

A. Material and equipment shall be protected during shipment and storage against physical damage, dirt, moisture, cold, and rain.

B. During installation, enclosures, equipment, controls, controllers, and other like items shall be protected against entry of foreign matter and be vacuum cleaned both inside and outside before testing and operating and repainting if required.

C. Damaged equipment shall be, as determined by the Designer, placed in first class operating condition or be returned to the source of supply for repair or replacement.

D. Damaged paint on equipment and materials shall be refinished to the satisfaction of the Designer

1.12 CORRELATION / COORDINATION OF WORK

A. Consult the drawings and specifications of Electrical, Mechanical, and other trades for correlating information and lay-out work so that it will coordinate with other trades. Verify dimensions and conditions (i.e. finished ceiling heights, footing and foundation elevations, beam depths, etc.) with the Architectural and Structural drawings. If conflicts occur such that resolution is not possible by the affected trades on the job, the Architect/Engineer shall be notified so that the proper changes can be made to avoid extra cost to the Owner.

B. Where work must be replaced due to the failure of the Contractor to verify the conditions existing on the job, such replacement must be accomplished at no cost to the Owner. This shall apply to shop fabricated work as well as to work fabricated in place.

C. Throughout the course of the work, minor changes and adjustments to the installation may be requested by the Engineer. The Contractor shall make adjustments, without additional cost to the Owner, where such adjustments are necessary to the proper installation and operation within the intent of the Contract Documents. This does not include work already completed.

D. Coordinate arrangement, mounting, and support of communications equipment so that pathways and connecting devices will be clear of obstructions and of the working and access space of other equipment. Allow maximum possible headroom unless specifically indicated otherwise. Provide for ease of disconnecting the equipment with minimum interference to other installations. Allow right of way for piping and conduit installed at required slope.

E. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

F. Coordinate sleeves, conduit, boxes, and any other pathway and/or rough-in installation requirements with the Electrical contractor. This shall include, but not be limited to, coordination of devices in precast concrete panels.

1. Coordinate exact locations of all precast construction with Architect, Construction Manager, Electrical contractor, and Precast Manufacturer.
2. Coordinate exact mounting locations and mounting heights in precast construction.
3. Verify that Electrical Contractor has obtained written confirmation from the precast manufacturer that all boxes and conduit have been installed and installed in the correct locations prior to the fabrication of the precast panels.

G. Coordinate selection and application of firestopping specified in Division 07 Section “Firestopping”.

H. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.13 CORRECTIVE PERIOD / GUARANTEE

A. The Contractor shall guarantee and maintain the stability of work and materials and keep same in perfect repair and condition for the period of one (1) year after the Date of Substantial Completion of the Project.

B. Defects of any kind due to faulty work or materials appearing during the above mentioned period must be immediately made good by the Contractor at their own expense to the entire satisfaction of the Owner and Architect and Engineer. Such reconstruction and repairs shall include damage to the finish or the building resulting from the original defect or repairs thereto.

C. This guarantee shall not apply to injuries occurring after final acceptance and due to wind, fire, violence, abuse or carelessness or other Contractors or their employees or the agents of the Owner.

D. This guarantee shall not apply where other guarantees for different lengths of time are specifically called for.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS.

A. Duly authorized distributors shall represent equipment and systems to be used on this project with service departments regularly engaged in the maintenance and installation of these systems and equipment. Such service departments shall regularly stock standard replacement parts and equipment and shall be located within a reasonable distance from the installation site.

2.02 MATERIALS

A. Materials and equipment shall be listed, labeled, or certified by a nationally recognized testing laboratory, such as Underwriters Laboratories (UL). Materials and equipment shall be new and of current production by a manufacturer regularly engaged in the manufacture of such items from which replacement parts shall be available. When items are specified by manufacturer's name or catalog designation, it shall be understood that this is to establish the class, features, function, capabilities, quality rating, and appearance.

2.03 APPROVAL / SUBSTITUTION OF MATERIALS

A. Refer to General conditions and Division 01 for substitution requirements.

1. Where approved substitutes are used, the Contractor assumes responsibility for physical dimensions and other resulting changes. This responsibility extends to include extra work required by other trades as result of the substitution. Substituted equipment requiring additional costs by other trades in its application shall have such costs borne by the contractor furnishing the equipment.
2. The Contractor shall assume any costs associated with the replacement of a non-specified product, unapproved by the Engineer, with an as-specified product.

2.04 OWNER'S RIGHT OF RETENTION

A. Firmware, hardware, and software which is necessary to run the Project systems and/or equipment provided hereunder, shall become the property of the Owner. Such firmware, hardware, and software shall be upgradable and/or editable by the Owner to facilitate future functional changes and/or additions or deletions without cost or the need for second party software.

2.05 SLEEVES FOR RACEWAYS AND CABLES

A. Sleeves shall be used for all cables passing through walls and floors. Coordinate with the Electrical Contractor.

B. Coordinate provision of sleeves for conduits passing through floors, footings, and/or exterior walls with appropriate trades.

C. Sleeves for penetrations through rated walls and floors shall conform to the requirements of Specification 07 84 00 "Firestopping".

2.06 FIRESTOPPING AND SEALS

A. Fire-stop wall, floor, and ceiling penetrations to the same fire-rating as the penetrated wall, floor, or ceiling. Firestop material shall comply with UL 1479, NEC 300-21, and NEC 800-3(c), and conform to the requirements of Specification 07 84 00 "Firestopping".

B. Seal all openings around sleeves, conduit, cable tray, or other work penetrating fire and smoke rated partitions, floors, and ceilings.

C. Seal all openings around sleeves, conduits, cable tray, or other work penetrating walls built to deck. Refer to Division 07 Section "Sealants and Caulking" for materials and installation. Refer to Architectural Details for more information.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Material, equipment, or systems as shown and/or specified shall be new and installed in accordance with manufacturer's recommendations and industry standards as applicable. Communications Work shall be installed in a professional, neat, workmanlike manner. NECA / NEIS is hereby adopted to define such workmanship of installation herein specified.
   1. Outdoor/Underground/Wet. All Div. 27 work installed where subject to the elements and/or water, wash down areas, shall be rated for such areas.
   2. Hazardous Locations: All Div. 27 work installed in classified hazardous areas shall be rated for such areas.

B. Provide all equipment, wiring, and accessories required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

D. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

F. Right of Way: Give to piping systems installed at a required slope.

3.02 EXAMINATION

A. Examine conditions for compliance with any communication equipment enclosure and ambient-temperature requirements for each enclosure.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and any other mounting surfaces for suitable mounting conditions where communication equipment will be installed.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products to be installed or turned over to Owner.

B. Store material and products in a clean and dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect products from dirt, water, construction debris, and traffic. Material and equipment shall be protected during shipment and storage against physical damage, dirt, moisture, cold, and rain. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items shall be protected against entry of foreign matter and be vacuum cleaned both inside and outside before testing and operating and repainting if required. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement. Damaged paint on equipment and materials shall be refinished to the satisfaction of the Architect/Engineer.

3.04 FIRESTOPPING

A. Apply firestopping material to penetrations of fire-rated floor and wall assemblies for installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

B. Seal all openings around conduit or other work penetrating fire and smoke rated partitions, floors, and ceilings. Communications materials and equipment shall be installed so as to prohibit the spread of fire. Fire-stop wall, floor, and ceiling penetrations to the same fire-rating as the penetrated wall, floor, or ceiling.

C. Where conduits, sleeves, cable tray, or other pathways for Div. 27 work penetrate a full-height-to-structure partition (sound wall), provide sealant to restore structure to its sound rating. Refer to Division 07 Section “Sealants and Caulking” for materials and installation.

3.05 TELECOMMUNICATIONS BONDING AND GROUNDING

A. Grounding and Bonding of communications equipment and materials shall be in accordance with NEC, ANSI/TIA-607-D, and manufacturer's requirements. All non-current carrying metals shall be bonded to the Telecommunications Bonding and Grounding system.

3.06 CLEAN UP

A. Contractor shall keep the premises free from accumulation of waste material or rubbish caused by their employees or work at all times Upon completion of the work they shall remove their rubbish, tools, scaffolding, and surplus materials from and about the building, and shall leave their work areas "broom clean" or its equivalent. In case of dispute, the Owner will remove the rubbish and charge the cost to the Contractor.

B. After tests have been performed and accepted, the Contractor shall go over the whole job and clean equipment installed by him/her, leaving the entire building in a clean and complete working order.

3.07 CUTTING, PATCHING, AND PAINTING

A. Cutting and Patching:

1. Perform and provide all cutting and patching of building materials as required for the installation of the work. No structural members shall be cut without the written approval of the Engineer/Architect and any such cutting shall be done in a manner satisfactory to the Engineer/Architect.
2. All patching of or repair of damage to work in place shall be done in a neat and workmanlike manner with the approval of the Engineer/Architect. The Contractor whose operations require cutting of work in place, or who cause damage which entails repairs of such work, shall employ mechanics of the particular trade whose work must be cut or which is damaged, and shall pay all costs of such patching or repair.
3. All holes through pre-cast concrete shall be drilled. Coordinate all pre-cast locations on the architectural and structural drawings.
4. Contractor shall be responsible for any additional cutting, patching, mounting/installation modifications not called out on the drawings but required for the successful completion of the job. This would include additional work required due to any existing jobsite conditions (ie: construction of walls, ceiling spaces, clearances, mounting requirements, existing equipment coordination, hazardous materials, etc.) that the contractor had an opportunity to determine in the pre-bid walk-through and could have reasonably determined before the bid by visual inspection or by asking the Engineer, Designer, or Owner. No additional money shall be awarded for additional work incurred caused by existing jobsite conditions which could have been verified by the contractor prior to bid. In addition, no additional money shall be awarded for failure to properly coordinate with the other trades.

B. Painting:

1. Refinish all communications equipment damaged during shipping and/or installation to its original condition. Remove all rust; prime, and paint per manufacturer's recommendations for finish equal to original.

3.08 FIELD TESTS AND ADJUSTMENTS

A. Work shall, upon completion, be subjected to such tests as are required under industry standards and/or specified herein. Acceptance of the Work by the Engineer shall be contingent upon satisfactory completion of these tests. Actual tests required shall be specified under their respective sections.

B. Prior to completion, the Work shall be subjected to a careful and thorough visual inspection to detect erroneous or loose connections, presence of foreign objects or materials, poor workmanship, compliance with drawings, or other abnormal conditions.

C. Test Reports shall be tabulated by the Contractor including the pertinent readings or observations, as well as a statement of the method and specific equipment employed, and shall be filed with the Engineer as part of the permanent Project record. In cases of test failure, refer to the appropriate specification section herein for specific direction as to how to proceed or manufacturer's requirements. A second test shall be conducted upon completion of repairs, adjustments, or replacements.

D. The Contractor shall provide calibrated test equipment as required for tests.

3.09 TRAINING

A. Training. The Contractor shall furnish training for the Owner's operating and maintenance personnel as stated within these specifications. Training shall be both of the classroom type and the hands-on type, and shall cover all areas of maintenance and operation. Training shall be coordinated with the Engineer and Owner to allow video recording, if requested by Owner.

1. The training period may be either concurrent with the system start-up or follow the start-up period at the Contractor's option; however, if it is given concurrent to the start-up, then the instructing personnel shall be furnished in addition to the start-up personnel and one shall not interfere with the other.
2. Actual training periods and their scopes shall be specified under their respective Section. Scheduling of the Owner's personnel shall be mutually agreed upon between the Contractor and the Project Engineer.

3.10 SUBMITTALS

A. The Contractor shall submit the following information to the Engineer:

1. Shop Drawings shall be first checked by the Contractor for space/dimensional considerations, performance characteristics, and general conformance to these plans and/or specifications, and shall be so stamped.
    a. Shop drawings not stamped as specified will be returned to the Contractor without action. Contractor's stamp shall include corporate name and address, the name of the checker, and the date. They shall then be sent to the General Contractor (as applicable) who will stamp them and forward to the Engineer.
    b. One copy of the shop drawings for any item shall be submitted to the Engineer for approval. Drawing size shall be no larger than 11" x 17".
    c. Submittals shall be grouped according to specification Sections and shall be labeled with the proper name of the project and specification Section. Partial submittals of a group or category will not be reviewed.
2. Test Report. Copy of test report, as detailed above, shall be submitted.
3. As-Built / Record Documents. A set of construction documents shall be continuously marked during progress of construction to show actual routing and makeup, equipment location changes, and variations between the project work, record-drawings, and the Contract documents. Such markings shall be made neatly and legibly with red felt-tipped pen. This set along with an electronically marked up and professional looking set of As-Built document shall be submitted. Submit with operation, maintenance and warranty data manuals.
4. Installation and Maintenance Manuals. Copies of Installation Instructions and Operation, Maintenance and Warranty Data Instruction Manuals shall be furnished for communications equipment provided. These Manuals shall include parts lists, troubleshooting methods, and calibration instructions. Manuals shall be constructed with hard cover post type binders such as Federal 'Super-Lok.' Large sheets shall be neatly folded and installed with posthole reinforcements such that the sheets will unfold without need to open binder posts. Manuals shall include index, section tabs, approved shop drawings, installation, operation, maintenance and warranty, data instructions packed with equipment, parts lists, and any other data as necessary and/or appropriate for the user to have.

3.11 COMPLETION OF INSTALLATION

A. System Acceptance. System optimization shall be performed to make sure that each communications system is properly installed and that all components are working properly. This shall include, but not be limited to:

1. Equipment is functioning properly.
2. Equipment is mounted in the correct location.
3. Equipment is rigidly and securely mounted.
4. Equipment is installed in a neat and visually professional manner.
5. Equipment is clean.

6. Equipment and cabling is clearly and properly labeled per ANSI/TIA-606 standards. Coordinate final labeling scheme with Owner and/or Designer.
7. The training of operations personnel is complete.
8. Final Inspection. Upon completion of the work, notify the Engineer that the Project is complete and ready for inspection. The Engineer will schedule an inspection and generate a list of items to be corrected or completed before contract closeout. If the Engineer is requested to make a final inspection by the Contractor, and the Engineer finds work is not complete enough to perform that inspection, the Contractor will compensate the Engineer for their time. The Contractor will then perform the necessary work to complete the project and again request a Final Inspection.

B. Spare Parts. Spare parts shall be turned over to the Owner at the completion of the Project. The spare parts shall not be used during start-up or warranty. Package spare parts for protection against dirt and moisture.

3.12 GUARANTEE (WARRANTY).

A. Unless specified in another Section, the warranty shall be described herein. The Contractor shall guarantee the equipment and systems to be free of defects in design, equipment, and workmanship for a period of one year from the date of acceptance as issued by the Architect's certificate of completion. The Contractor shall replace, redesign, and correct any equipment that fails within the one-year period.

END OF SECTION 27 05 00

SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.01 SUMMARY

A. Introduction:
   1. This Section includes the furnishing and installation of all labor, material, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of communications equipment room fittings for new Telecommunications Rooms as shown, required, and specified herein. The omission of express reference to any items or work necessary for, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor form providing such items or work.

1.02 SCOPE AND INTENT

A. Renovation at the Nelson Care Center by Vivie. Project scope includes, but is not limited to, demolition of an existing telecommunications enclosure as well as establishing new telecommunications rooms. Refer to specification sections and drawings for additional information.
B. This is a phased project. Coordinate with the Construction Manager.
C. This Section Includes:
   1. Telecommunications mounting elements
   2. Backboards
   3. Telecommunications equipment racks
   4. Power Distribution Units (PDU)
   5. UPS
   6. Bonding of equipment room fittings to Telecommunications Bonding and Grounding System
   7. Ladder Rack

1.03 RELATED DOCUMENTS

A. The following sections, along with this section, provide a structured cabling system as shown on the drawings.
   1. Common Work Results for Communications (Section 27 05 00)
   2. Communications Backbone Cabling (Section 27 13 00)
   3. Communications Horizontal Cabling (Section 27 15 00)
   4. All Division 27 or 28 specifications included for equipment housed within a telecommunications room, telecommunications enclosure, equipment room, or entrance facility.
B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.04 ABBREVIATIONS

A. AHJ: Authority Having Jurisdiction
B. AWG: American Wire Gauge
C. BICSI: Building Industry Consulting Services, International
D. CMP: Communications Plenum (cable)
E. EMI: Electromagnetic Interference
F. HVAC: Heating, Ventilation, and Air Conditioning
G. ITSIMM: BICSI's Information Transport Systems Installation Methods Manual
H. NFPA: National Fire Protection Association
I. NIC: Not in Contract
J. OFE: Owner Furnished Equipment
K. PBB: Primary Bonding Busbar
L. PDU: Power Distribution Unit
M. RBB: Rack Bonding Busbar
N. RCDD: Registered Communications Distribution Designer
O. RU: Rack Unit

P. SBB: Secondary Bonding Busbar
Q. TBB: Telecommunications Bonding Backbone
R. TEBC: Telecommunications Equipment Bonding Conductor
S. UPS: Uninterruptable Power Supply

1.05 DEFINITIONS

A. Approved Equal: Indicates equal in materials, size, color, design, function, capabilities, and performance of specified and conforming with base bid manufacturer.
B. Furnish: Delivery to job site or where called for.
C. Furnished by Others: Receive delivery at job site or where called for and install.
D. Future Equipment: Indicates equipment that will be added to the system by the Owner or Owner's contractor at a later date. Provisions shall be made for this equipment.
E. Not In Contract (NIC): Refers to work or equipment that is not in contract covered in this section, but is shown or described for reference.
F. Owner Furnished Equipment (OFE): Contractor coordinates the integration of existing or new components furnished by the Owner into the system. Contractor provides required installation components, hardware, cables, connectors, etc. to incorporate the OFE as specified unless noted otherwise.
G. Protect: Shield from damage and preserve condition.
H. Provide: Furnish and install.
I. Relocate: Disassemble, disconnect, protect, and transport equipment to new locations, then clean , test, and install ready to use.
J. Replace: Remove and provide new item.
K. Top Tier: Of the highest level of quality

1.06 REFERENCES

A. The products and work provided by this section shall comply with the following applicable references, standards (latest edition), and codes:
    1. ANSI/TIA Telecommunications Building Standards:
        a. ANSI/TIA-569-D: Telecommunications Pathways and Spaces.
        b. ANSI/TIA-606-C: Administration Standard for Commercial Telecommunications Infrastructure.
        c. ANSI/TIA-607-D: Generic Bonding and Grounding (Earthing) for Customer Premises.
        d. ANSI/TIA-942-B: Telecommunications Infrastructure Standard for Data Centers
        e. EIA/ECA-310-E: Cabinets, Racks, Panels, and Associated Equipment
    2. NFPA 70 National Electrical Code
    3. BICSI Telecommunications Distribution Methods Manual
    4. Underwriter's Laboratories (UL)

1.07 COORDINATION

A. Coordinate layout and installation of communications equipment room fittings with the electrical contractor, Owner's service providers, Owner's equipment providers, security integrators, public address system contractor, audio/visual integrator, and any other contractors with equipment housed within the telecommunications spaces.
B. Construction Meetings:
    1. Attend construction meetings for coordination with other disciplines and trades for proper time and sequence to avoid installation delays.
    2. Coordinate electrical requirements with electrical contractor.
    3. Coordinate with other trades installing in the telecommunications room for equipment layout. [Refer to details on drawings for equipment locations]

1.08 EXISTING CONDITIONS

A. This is an active facility with a phased construction and demo approach. Contractors will maintain connectivity in all active areas and shall pay attention during demo as not to disconnect active connections. All existing backbone connectivity shall be maintained until new backbone has been installed and cutover.

B. Boiler Room TR rack will be demoed. It contains 123 data cables, it serves data locations where renovation is not planned for. However, to completely demo this TR rack, those cables will need to be replaced as part of this contract. Contractor will demo all cables that are part of the planned construction demo to this TR, while maintaining the existing active data connections going to this TR that are serving outside of renovation area. After the new TR (A124) is established, the contractor will pull new data cables from new TR to all locations outside of the renovation area that this Boiler room TR served. These locations outside of the renovation area will be active and will require cables to be pulled while existing is in place, terminated on the new TR side, then cut over on the user end from the old cabling/jacks to the new and patched. Contractor will use new jacks and faceplates for these replacement terminations. After the cutover, demo existing cabling back to boiler room TR and remove rack and associated rack components. Contractor to plan for proper labor for cutover to new cabling in a phased approach to lesson active residence impact. This includes working with IT to re-establish/patch connectivity.

C. All Coax Tap locations throughout the facility will be maintained and will be used for any new cabling.

D. There are two areas that have hard deck ceilings. Main entry in the admin area and long hallway between B124 closet and Server Room C closet. Additional labor and material will be required to accommodate these areas.

1.09 SUBMITTALS

A. Shop Drawings shall be submitted for approval for all communications equipment room fittings prior to commencing installation. Refer to specification section 01 for additional information on form and content of submittals.

1. Provide a complete materials list, listing quantity, manufacturer, model number and description of the system components listed below
2. Provide list of equipment lead times. Identify equipment lead times having a major impact on work by other trades so as not to delay the job, impact the schedule, or add cost to the project.
3. Provide a manufacturer's specification sheet for the system components listed below. Product sheets shall include construction details, material descriptions, dimensions of individual components and profiles, finishes, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Identify the actual part numbers to be utilized using highlights, arrows, or clouds.
4. System components:
    a. Equipment **racks** and all assembly components
    b. Pathways and supports
    c. PDUs
    d. Bonding to Primary Bonding Busbar (PBB) and/or Secondary Bonding Busbar (SBB) – products and methods
    e. Plywood
    f. UPS
5. Qualification Data:
    a. Provide manufacturer certification credentials of staff assigned to project
    b. Provide low voltage licensure credentials
6. Provide samples of any or all proposed system components requested for examination/approval

B. As-Built documents shall be submitted for approval for all communications equipment room fitting components listed below. Refer to specification section 01 for additional information on form and content of submittals. Include the following documents:

1. As-Built Drawings on floor plans in 1/8" scale showing room layout and components of every Telecommunications Room or enclosure. Equipment shall be indicated by its final label identifier. Handwritten data is not acceptable. Layout of every telecommunications room shall include, but not be limited to:
    a. Equipment rack, cabinet and/or enclosure locations
    b. Ladder rack layout

c. All pathway entrances
d. Primary Bonding Busbar (PBB) and/or Secondary Bonding Busbar (SBB) location(s), mounting detail showing standoff insulators and wall mounting brackets, and all items bonded to the PBB and/or SBB
e. Plywood locations
f. All equipment mounted on plywood. This shall include other discipline's equipment as well, such as security.

2. Manufacturer's specification sheet for the system components provided.
3. Operation and maintenance manuals
4. Manufacturers' required maintenance related to system warranty required
5. Warranty data

1.10 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Provide products from manufacturers that are top tier and have been in business for a minimum of 5 years.

B. Product Qualifications:
1. Provide materials listed by a qualified testing agency and marked for intended location and application.

C. Contractor Qualifications:
1. Minimum of five years local experience installing telephone, data, and fiber optic structured cabling systems.
2. Two structured cabling system networks installed locally and operating for a minimum of one year.
3. Local support center.
4. Place of business that locally maintains the necessary spare parts in the proper proportion to this project, as recommended by the manufacturer, to maintain and service the equipment being supplied.

D. Project Installer Qualifications:
1. Layout Responsibility: Preparation of Shop Drawings and As-Built documents by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of an BICSI Certified Technician, or Manufacturer's Certified Technician. Supervisor shall be present at all times when Work of this Section is performed at Project site. RCDD shall conduct a site visit to inspect installations a minimum of once a week.
3. Installers: Certified by manufacturer of product(s) installed or have equivalent BICSI certification.

E. Provide, upon request, Contractor information as follows:
1. Period of time Contractor has installed similar systems.
2. List of all similar system installed locally within the last five years, indicating the following:
a. When system was installed
b. Name and telephone number of reference person for each system.
3. Description of installation capabilities, indicating the following:
a. Name, registration number, and registration expiration date of RCDD
b. Length of time every technician has been employed in the telephone, data, and fiber optic structured cabling installation business.
c. Length of time every technician has been employed by the Company.

1.11 DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Until final acceptance of work, Contractor shall protect all materials and equipment from damage.
1. Any components stored or installed on-site shall be, at a minimum, protected with polyethylene or equivalent covering to protect from moisture, plaster, cement, paint, or other work of other trades.
2. If during shipment or installation, finish or equipment becomes chipped or scratched, Contractor shall touch up or refinish surfaces to match original finish.
3. Contractor is responsible to protect Owner's furnishings from damage due to their activities in occupied spaces and to clean up any debris created as a result of their work.

1.12 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment until wet work in spaces is complete and dry and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All equipment and materials shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 and NECA/BICSI/TIA standards.

1. Materials shall be UL listed
2. Materials shall comply with Industry Standards.
3. Materials shall be in new, original-manufacturer packaging.
4. Materials shall not be remanufactured, refurbished, recertified, or reused in any way.
5. Materials shall be procured via manufacturer-intended distribution channels.

2.02 CABLE PATHWAYS AND SUPPORTS

A. General Requirements: Comply with ANSI/TIA-569-D.

B. Cable Support:

1. Description:
   a. Lacing bars, spools, J-hooks, D-rings, straps, and other devices
   b. Shall be NRTL labeled for support of Category 6 cabling.
   c. Shall have brackets designed to prevent degradation of cable performance and pinch points that could damage cable.
   d. Shall have cable tie slots to fasten cable ties to brackets.
   e. Shall comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
   f. D-Rings shall be non-conductive with smooth bearing surfaces to manage wire bundles within the telecommunications rooms.
2. Quantity:
   a. Appropriate quantity to provide support of cable a minimum of every 4 feet.

C. Cable Ties:

1. Description:
   a. Shall be non-metallic hook and loop reusable (Velcro).
2. General Requirements:
   a. Straps shall be tightened to just support the cables without distortion of individual cables with a bundle.
   b. Plastic tie-wraps are unacceptable.
   c. Shall be plenum rated in plenum rated spaces.

D. Ladder rack:

1. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
   a. Chatsworth Products, Inc.
   b. Hoffman
2. Description:
   a. Shall provide pathway for support of backbone cables, patch cords, and horizontal cable service loops.
   b. Shall come in a variety of sizes.
   c. Shall be constructed of high strength steel and smooth formed surfaces and edges that protect cabling from damage and maintain specified cabling bend radius.

d. Shall have a textured black powder coat.
e. Width shall be 18” unless noted otherwise on plans.
f. Shall utilize off-set brackets, minimum of 6”, to raise ladder rack above the racks.

3. Quantity:
   a. Provide a stabilizing ladder rack bracket mounted from adjacent wall to top of rack.
   b. Provide ladder rack for routing of cables as shown on drawings for each telecommunications room.

2.03 BACKBOARDS

A. Description of Plywood:
   1. Shall be kiln-dried to maximum moisture content of 15%.
   2. Shall be fire-retardant treated with fire-retardant chemicals by a pressure impregnation process.
   3. Painting
      a. The Plywood shall be painted with primer and two coats of white paint on all sides and within cutout areas.
      b. Mask the stamp on each sheet prior to priming and painting. Leave the stamps exposed and visible for long-term maintenance awareness.
   4. Shall be AC grade
   5. Shall be 3/4 by 48 by 96 inches
   6. Shall be void free
   7. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

B. Quantity:
   1. Provide plywood on all walls in each telecommunications room, unless shown otherwise on the plans and details.

2.04 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. APC / Schneider Electric
   2. Chatsworth Products, Inc.
   3. Great Lakes Case & Cabinet
   4. Hubbell Premise Wiring
   5. Middle Atlantic Products, Inc.
   6. Pentair Hoffman
   7. Panduit Corp.
   8. Siemon

B. Description:
   1. General Frame Requirements:
      a. Shall be compliant with EIA/ECA-310-E: Cabinets, Racks, Panels, and Associated Equipment Standard
      b. Shall be compatible for mounting standard, 19-inch width equipment
      c. Shall be painted with Manufacturer's standard, durable black powder coat
      d. Shall have associated cable management components that are factory-engineered to connect and function together as a system.
   2. 2-Post Floor Mounted Open Frame Rack:
      a. Shall be modular-type, aluminum construction two-post open frame rack
      b. Dimensions: 84” x 19” x 3”
      c. Shall have equipment mounting rails drilled and tapped for universal screw fitting, compliant with EIA/ECA-310-E.
      d. Bottom of rack shall have holes for bolting to floor.
      e. Shall have top and bottom cable troughs, grounding lug, and a power strip.

f. Shall be fitted on both front and rear with vertical cable management that has been factory-engineered to connect and function together as a system.
g. Shall be fitted with horizontal cable management that has been factory-engineered to connect and function together as a system.
h. All floor mounted racks provided shall be from the same manufacturer and from the same product series from that manufacturer.

3. Wall Mounted Rack
a. Dimensions: 48.50” x 20.75” x 32” (26 RU)
b. Shall have standards-based mounting holes
c. Shall have a minimum of 100 lbs. weight capacity
d. Shall have rear hinged section
e. Shall be reversible for left or right-hand swing
f. Shall include isolated copper bus bar for 19” mount

C. Quantities:
1. Refer to plans and detail drawings for quantities and additional information
2. Provide a bag of 100 screws (per rack) that match the rack provided. Turn over to Owner.

D. Wire Management for Equipment Frames:
1. Top tier integral wire retaining fingers
2. Finish to match rack
3. Vertical cable management panels shall be top tier and have front and rear channels with covers
a. Covers shall be one piece, full length, and hinge from both directions with integrated latches
b. Size: Minimum of 6” width, unless noted otherwise on plans.
c. Quantity: Provide between and on the ends of each 2-post rack.
4. Horizontal wire management shall have hinged front covers and rear cover to match and align with vertical managers.
a. Size: (2) RU unless noted otherwise on plans.
b. Quantity: Provide at top, middle and bottom of each rack. Short patch cords will be used to manage between switches and panels.

2.05 POWER DISTRIBUTION UNITS (PDU)

A. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
1. APC
2. CPI
3. CyberPower
4. Eaton
5. Hoffman
6. Tripplite
7. Approved equal

B. Description:
1. Shall comply with UL 1363
2. Shall be rack mounting in 0U(vertical) of space in a standard 19” 2-post and rack mounting in 1U (horizontal) of space in wall mounted rack.
3. Input: to match the UPS provided
4. Output**:** Twenty (2 post rack), twelve (wall mount rack) 20-A, 120-VAC, NEMA 5-20 receptacles
5. Shall have LED indicator lights for reverse polarity and open outlet ground.
6. Shall have Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Shall have a rocker-type on-off switch, illuminated when in “on” position
8. Shall provide EMI/RFI noise filtering

C. Quantity:
1. Provide a minimum of one per rack, unless indicated differently in detail drawings on plans.

2.06 UNINTERUPTABLE POWER SYSTEM (UPS)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. APC
   2. Cyber Power
   3. Eaton
   4. Approved equal

B. Description
   1. 30 amp, 208 volt input
   2. Provide cord, minimum length of 8 ft., with L5-30P locking 30A plug
   3. Output Connections: (2) NEMA L6-20R (Battery Backup) and (2) NEMA L6-30R (Battery Backup)
   4. Rack mountable
   5. 9 minutes run time at full load
   6. Typical recharge time of 3 hours
   7. Maintenance-free sealed lead-acid battery with suspended electrolyte
   8. Full time multi-pole noise filtering that meets UL 1449
   9. LED status display with load and battery bar-graphs the following indicators:
      a. On Line
      b. On Battery
      c. Replace Battery
      d. Overload
   10. Audible alarm:
      a. On battery
      b. Distinctive low battery
      c. Configurable delays
   11. Provide network management card for remote management of the UPS over the data network
   12. Provide 2 year warranty
   13. Quantity: One (1) per Telecommunications Rack.

2.07 TELECOMMUNICATIONS BONDING AND GROUNDING

A. General Requirements:
   1. Coordinate Primary Bonding Bar (PBB) and Secondary Bonding Bar (SBB) installation with Division 26.
   2. Telecommunications Equipment, raceways, and any other exposed non-current carrying metals shall be properly bonded to the PBB and/or SBB in accordance with ANSI/TIA-607-D: Generic Bonding and Grounding (Earthing) for Customer Premises and NFPA 70 (National Electrical Code

B. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
   1. Burndy
   2. Harger
   3. Hubbell
   4. Panduit
   5. Approved equal

C. Description:
   1. Connectors:
      a. Shall be mechanical type, cast silicon bronze, solderless compression or exothermic-type wire terminals, and long-barrel with inspection window, two-bolt connection to ground bus bar.
   2. Jumpers:
      a. Shall be a minimum of #6 AWG
   3. Bonding hardware:
      a. Shall be bonding screws or paint-piercing washers.

2.08 LABELING

A. General Requirements:
   1. Shall comply with ANSI/TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
   2. Labeling stock shall support laser printing and have a clear overwrap.
   3. Refer to Section 27 15 00 for labeling scheme.

B. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
   1. Panduit
   2. Approved equal

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Common work for communication systems shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 and NECA/BICSI, ANSI/TIA latest edition is hereby adopted to define such workmanship and the installation of communications equipment room fittings.

3.02 EXAMINATION AND PROJECT CONDITIONS

A. Examine products before installation. Reject products that are physically damaged.

B. Examine conditions for compliance with any communication equipment room fittings and ambient-temperature requirements for each enclosure.

C. Verify that field measurements are as needed to maintain working clearances required by NECA/BICSI/ANSI/TIA and manufacturer's written instructions.

D. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where communications equipment room fittings will be installed.

E. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

F. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 DEMOLITION

A. Where demolition is indicated on drawings or project documents, Contractor shall be responsible for removal, collection, transportation, and disposal of all indicated communications equipment room fittings.

B. Contractor shall remove rack. bonding to SBB, backboards and properly and legally dispose of demolished materials without additional cost to the Owner. Contractor will confirm with owner any items that they would like to keep.

C. Contractor shall field-verify existing conditions prior to beginning demolition work. All discrepancies between existing conditions and specifications or drawings shall be reported to the Architect prior to the start of work in order to prevent disturbance of existing installations. Beginning work shall indicate acceptance of existing conditions. Contractor is responsible for immediately restoring any outages caused as a result of damaged cabling, systems, or services.

D. If the Contractor removes any pathway from an opening in a fire-rated wall, the Contractor shall restore the fire-rating condition of the wall to the same condition as before the Contractor started the work. Depending on the size of opening, this may involve sheetrock patching, in addition to use of other appropriate fire-stopping materials.

3.04 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers.
   1. Meet jointly with telecommunications and LAN equipment suppliers and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of all network equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
5. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
6. Coordinate arrangement, mounting, and support of communications equipment:
    a. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
    b. To provide for ease of disconnecting the equipment with minimum interference to other installations.
    c. To allow right of way for piping and conduit installed at required slope.
    d. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
7. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
8. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section “penetration Firestopping”.

B. Entrance Facilities
1. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider
2. Coordinate the installation of underground or buried entrance pathway and appropriate locations within the room. Comply with Division 26 Section “Raceway and Boxes for Electrical Systems”

3.05 INSTALLATION

A. Comply with NECA 1.
B. Comply with the most current edition of the BICSI TDMM for layout and installation of communications equipment rooms.
C. Comply with NEMA VE 2 and ANSI/TIA-569-D for cable tray/ladder rack installation.
D. Telecommunications pathways, spaces, and metallic cables which run parallel with electric power or lighting, which is less than 3KVA, shall be installed with a minimum clearance of 50 mm (2 in).
E. Cables:
1. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
2. Manage cable bundles. Hook and loop reusable cable ties (Velcro) shall be tightened to just support the cables without distortion of individual cables with a bundle. Bundles shall not exceed 24 cables or manufacturer’s recommendations.
3. Plastic tie-wraps shall not be used to secure any cables, at any time, even temporarily during installation.
4. Crossovers of cable spans arriving from different directions shall be avoided

F. Racks:
1. Each equipment racks shall be bolted to the floor with a fastening system suitable for the floor material.
2. Maintain a minimum of 3.28’ unobstructed clearance from the front and back edge of all racks to any device or backboard.
    a. Allow for a minimum of 6” depth off backboard for wall-mounted equipment.
    b. Allow for depth of rack-mounted equipment.
3. Allocate a minimum of 3.28’ (wide) x 3.28’ (deep) x 7.5’ (high) for each equipment rack, cabinet, or enclosure.

4. Install horizontal and vertical cable management modules with strain relief brackets.
5. Brace racks to the wall with cable ladder rack. Multiple racks in the same room shall be interconnected with cable ladder racks.
6. Provide electrical continuity between rack elements by using paint piercing grounding washers. Provide where rack sections bolt together, on both sides, under the head of the bolt, and between the nut and rack.
7. Shall be bonded in accordance with the methods prescribed in the most current edition of the BCSI TDMM.
8. Refer to Identification within these specifications and detail drawings to provide appropriate labeling

G. Wall Racks:
1. Mount rack to plywood with hardware appropriate for maximum weight of a fully populated rack. Mounting hardware shall screw directly into the wall studs.
2. Maintain a minimum of 3-foot clearance from the front of cabinet and cabinet swing to any device or backboard.
3. Verify with Owner and/or Designer if swing is to be right or left-hand.
4. Attach ground wire from to rack. Electrical continuity throughout each rack is required.
5. Swing shall be square with cabinet frame.
6. Shall be level and plumb.
7. Install rack bonding busbar (RBB) inside of cabinet in accordance with the grounding requirements outlined in the BICSI TDMM Chapter 9, current edition.
8. Verify that rack installation location is not in or adjacent to areas contain sources of electromagnetic interference (EMI).
9. Refer to Identification within these specifications and detail drawings to provide appropriate labeling.

H. Ladder Rack:
1. Ladder rack shall be securely fastened to top of rack with minimum of 6” offset provided by rack or tray manufacturer.
2. Electrical continuity throughout ladder rack installation is required.
   a. Provide and install paint piercing washers or scrape paint to metal at fastening points to provide a conductive path for electrical bonding between components.
   b. Individual segments of ladder rack shall be bonded together on both sides to form an electrically continuous installation.
   c. All bonding and grounding components must be approved by the cable support system manufacturer.
3. Provide a second layer of ladder rack for management of cable service loop if necessary.

I. Plywood:
1. Provide on all walls or as indicated on plan drawings.
2. Fire retardant plywood stamp shall be exposed and visible. In the event of painting, mask stamp on each sheet prior to priming and painting.
3. Hang 8” above finished floor extending up to a height of 8’8” above finished floor.
4. Hang with the grade A surface exposed.
5. Secure to wall at wall-framing members to ensure that it can support attached equipment.

J. Grounding and Bonding:
1. General Requirements:
   a. The grounding/earthing system shall be intentional, visually verifiable, and adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment.
   b. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors and Division 27 as indicated herein.
   c. Building steel and metallic water piping may not be substituted for the telecommunications bonding backbone (TBB).

2. All equipment racks, metallic conduits, ladder racks, and exposed non-current carrying metal parts of telecommunications and information technology equipment shall be bonded to the Telecommunications Bonding and Grounding System per NEC, local electrical code, and manufacturer's recommendations. Reference ANSI/TIA-607-D: Generic Bonding and Grounding (Earthing) for Customer Premises and Chapter 8 Bonding and Grounding (Earthing) of the most current edition of the BICSI TDMM
3. Bonding conductors shall:
    a. Run without splices between termination points
    b. Avoid unnecessary loops
    c. Not have sharp bends
    d. Not be excessive in length
    e. Run directly as possible
    f. Be terminated at each end using UL-listed termination methods
    g. Have inspection windows allowing for connections to be inspected for full conductor insertion
    h. Have die index numbers embossed on all compression connections to allow crimp inspection.
    i. Have solid mechanical compression terminations that are irreversible.
    j. Be installed only after removing all paint, grease, and other interfering substances.
    k. Have bonding hardware that breaks through paint and powder coatings to make solid, reliable contact with the metal substrate.
    l. Have terminations at the grounding busbar made with dual-hole, dual-crimp lugs with two 300-series stainless steel hex-head bolts, properly crimped using crimping/swaging tool and tightened to meet manufacturer's torque specifications, 2-ton minimum pressure, the greater shall apply. Phillips-head screws are not acceptable.
    m. Use antioxidant compound when making bonding connections in the field. The antioxidant shall be appropriate for the materials being bonded together.
    n. Be no smaller than No. 6 AWG and green in color.
    o. Be labeled to identify the termination point of the opposite end of the conductor. The labels shall be non-metallic material.
4. Coordinate with Electrical Contractor to ensure that Grounding and Bonding Conductors have been appropriately sized according to requirements in ANSI/TIA-607-D: Generic Bonding and Grounding (Earthing) for Customer Premises**].**
5. Coordinate with Electrical Contractor to ensure that the PBB and SBB have been sized to allow for at least 25% additional unused terminal spaces for future use after the project has been completed.
6. Coordinate with the Electrical Contractor to ensure that a #2 AWG bonding conductor is provided between the grounding busbar in the technical power panel and the SBB. Other sizes shall be according to ANSI/TIA-607-D Table 1
7. Refer to Identification within these specifications and detail drawings to provide appropriate labeling.
8. Refer to drawings for grounding riser.

3.06 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."
B. Comply with ANSI/TIA-569-A, Annex A, "Firestopping."
C. Comply with most current edition of the BICSI TDMM, "Firestopping Systems" Article.
D. All conduits shall have heat sealable inserts, fire stopped, or sound-proofed at the conclusion of the project.
E. Where non-mechanical products are utilized, provide products that upon curing do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.

F. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.

G. Openings for cable trays shall be sealed using re-enterable fire stopping pillows in fire-rated walls and sound-proofing material in non-fire-rated walls.

3.07 IDENTIFICATION

A. Identify system components, wiring, and cabling in compliance with ANSI/TIA-606-C.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

C. Comply with requirements in Division 09 Section "Interior Painting" for painting of backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Labels shall be preprinted or computer-printed type and shall comply with ANSI/TIA-606-C and UL 969, including but not limited to label stocks, laminating adhesives, and inks used by label printers. P-Touch labeling and similar labeling equipment is not acceptable.

E. A unique identifier shall be marked on each piece of connecting hardware.

F. Refer to Section 27 15 00 for horizontal cable labeling scheme

G. Confirm final labeling scheme with Technology Designer and Owner prior to installing labels.

3.08 CLEANING AND PROTECTION

A. Upon completion of installation of communications equipment room fittings, clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

B. Provide final cleaning, protection, and maintain conditions in a manner acceptable to manufacturer, which ensures system being free from damage and deterioration at time of Substantial Completion.

3.09 WARRANTY

A. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Warranty period shall begin on the date of acceptance as issued by the Architect’s certificate of completion.

END OF SECTION 27 11 00

SECTION 27 13 00
COMMUNICATIONS BACKBONE CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Introduction:

B. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of a completely operational communications backbone cabling system as shown, required, and specified herein. The omission of express reference to any items or work necessary for, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor from providing such items or work.

C. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

D. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

E. Scope and Intent:

1. Renovation at the Nelson Care Center by Vivie. Project scope includes, but is not limited to, establishing backbone in phases, demolition of existing backbone cabling and providing new fiber backbones. Refer to specification sections and drawings for additional information.
2. This is a phased project. Coordinate with the Construction Manager.

F. This Section Includes:

1. Pathways
2. 50/125 µm multimode optical fiber cabling (OM4)
3. Cable connecting hardware, patch panels, and cross-connects
4. Cabling identification products
5. Patch cables
6. Testing

1.02 RELATED DOCUMENTS

A. The following sections, along with this section, provides a structured cabling system as shown on the drawings.

1. Common Work Results for Communications (Section 27 05 00)
2. Communications Equipment Room Fittings (Section 27 11 00)
3. Communications Horizontal Cabling (Section 27 15 00)

1.03 DEFINITIONS

A. 8P8C – Eight Position, Eight Contact
B. AWG – American Wire Gauge
C. BICSI – Building Industry Consulting Services, International
D. CMP – Communications Plenum (cable)
E. EMI – Electromagnetic Interference
F. Gbps – Gigabits per Second
G. HVAC – Heating, Ventilation, and Air Conditioning
H. IDC – Insulation Displacement Contact
I. ITSIMM – BICSI's Information Transport Systems Installation Methods Manual
J. OFCP – Optical Fiber Conductive Plenum
K. OFNP – Optical Fiber Nonconductive Plenum
L. OTDR – Optical Time Domain Reflectometer
M. RCDD – Registered Communications Distribution Designer
N. RU – Rack Unit

O. STP – Shielded Twisted Pair
P. TBB – Telecommunications Bonding Backbone
Q. TGB – Telecommunications Grounding Busbar
R. TDMM – BICSI's Telecommunications Distribution Methods Manual
S. UTP – Unshielded Twisted Pair

1.04 REFERENCES

A. Standards:
1. ANSI/TIA-455-C-2014: General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components
2. ANSI/TIA-455-78B: FOTP-78 IEC 60793-1-40 Optical Fibres-Part 1-40: Measurement Methods and Test Procedures – Attenuation
3. ANSI/TIA-526: Standard Test Procedures for Fiber Optic Systems
4. ANSI/TIA-526-7-A-2015: Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement
5. ANSI/TIA-526-14-C-2015: Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedures – Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement
6. ANSI/TIA-568-D Series: Generic Telecommunications Cabling for Customer Premises, Commercial Building Telecommunications Cabling Standard, Balanced Twisted-Pair Cabling Systems Standards.
7. ANSI/TIA-569-D: Telecommunications Pathways and Spaces
8. ANSI/TIA-598-D: Optical Fiber Cable Color Coding
9. ANSI/TIA-606-B: Administration Standard for Commercial Telecommunications Infrastructure.
10. ANSI/TIA-607-D: Commercial Buildings Grounding and Bonding Requirements for Telecommunications.
11. BICSI Telecommunications Distribution Methods Manual
12. BICSI Information Technology Systems Installation Methods Manual
13. BICSI Network Design Reference Manual
14. BICSI ICT Installation Practices Field Guide, Volume 1 – General Cabling, 1st Edition

B. Codes:
1. NFPA 70 National Electrical Code

1.05 INSPECTION OF SITE BEFORE CONSTRUCTION

A. Pre-Installation Meeting:
1. Arrange for pre-construction meetings to coordinate installation of backbone cabling system with Owner's representative including but not limited to, facilities staff, maintenance, IT, and administrative staff. The Architect's Technology Designer shall be included in these meetings.
2. Meeting shall include review of entire installation, including locations of equipment, layout of equipment in spaces, labeling schemes, features, functions, capabilities, and integrations.
3. Review phasing of systems through the duration of the project.
4. Take attendance and minutes and submit with the close out documents.

B. Construction Meetings:
1. Attend construction meetings for coordination with other disciplines and trades

1.06 COORDINATION

A. Coordinate layout and installation of communications backbone cabling with Owner, cable tray installation, electrical piping, mechanical piping, mechanical ductwork, etc.
B. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping.

1.07 EXISTING CONDITIONS

A. Existing fiber is 62.5 and owner would like to replace with OM4.

B. This is an active facility with a phased construction and demo approach. Contractors will maintain connectivity in all active areas and shall pay attention during demo as not to disconnect active connections. All existing backbone connectivity shall be maintained until new backbone has been installed and cutover.

C. There are two areas that have hard deck ceilings. Main entry in the admin area and long hallway between B124 closet and Server Room C closet. Additional labor and material will be required to accommodate these areas.

1.08 SUBMITTALS

A. Shop Drawings shall be submitted for approval for all communications backbone cabling components prior to commencing installation. Refer to specification section 01 for additional information on form and content of submittals.

1. Provide a complete materials list, itemizing quantity, manufacturer, model number and description of the system components listed below.
2. Provide a manufacturer's specification sheet for the system components listed below. Identify the actual part numbers to be utilized using highlights, arrows, or clouds.
3. System components:
    a. Fiber Optics
        1) Fiber optic cable (all types and/or jacket varieties required for this project)
        2) Fiber optic cable connectors (all styles required for this project)
        3) Fiber optic patch panels
        4) Fiber optic patch cables
4. Provide qualification documents as follows:
    a. Manufacturer certification credentials of staff assigned to project for installation or a BICSI equivalent certification
    b. RCDD credentials for staff assigned to supervise this project. In the event that the assigned RCDD changes during the course of this project, credentials for the newly assigned RCDD shall be submitted to the Technology Designer.
    c. Manufacturer's certification indicating capability to provide a minimum of 20 year warranted system
    d. Low voltage licensure credentials for staff assigned to project for installation.

B. As-Built Documents shall be submitted for approval for all communications backbone cabling components listed below. Refer to specification section 01 for additional information on form and content of submittals. Include the following documents:

1. As-Built Drawings showing locations of all cable routing and termination points, conduit routes and sizes, strand counts, and fiber type(s) on complete floor plans of 1/8" scale. Handwritten routes and data are not acceptable.
2. Equipment cabinet layouts
3. Labeling schemes and schedules.
    a. Electronic copy of labeling schedules in software and format selected by Owner.
    b. Cabling administration drawings and printouts
4. Equipment installation details
5. Operation and Maintenance Data and/or Manuals
6. Test Results
7. Record of Warranty

1.09 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Provide connectivity and cabling products from manufacturers that are top tier premium partners offering the longest available warranty from the manufacturer (minimum of 20 years).

B. Product Qualifications:

1. Provide materials listed by UL or ETL.

C. Contractor Qualifications:
   1. Minimum of five years local experience installing telephone, data and fiber optic structured cabling systems.
   2. Two structured cabling system networks installed locally and operating for a minimum of one year.
   3. Local support center.
   4. Place of business that locally maintains the necessary spare parts in the proper proportion to this project, as recommended by the manufacturer, to maintain and service the equipment supplied.

D. Project Installer Qualifications:
   1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of an BICSI Certified Technician, or Manufacturer's Certified Technician. Supervisor shall be present at all times when Work of this Section is performed at Project site. RCDD shall conduct a site visit to inspect installations at a minimum of once a week.
   3. Testing Supervisor: Currently certified by BICSI as a Certified Installer or industry recognized equivalent to supervise on-site testing.
   4. Installers: Certified by manufacturer of product(s) installed or have equivalent BICSI certification. Shall have capability to provide a minimum of 20-year Manufacturer's warranty from the Manufacturer of product provided for this project.

E. Provide, upon request, Contractor information as follows:
   1. Period of time Contractor has installed similar systems.
   2. List of all similar systems installed locally within the last five years, indicating the following:
      a. When system was installed.
      b. Name and telephone number of reference person for each system.
   3. Description of installation capabilities, indicating the following:
      a. Number of local technicians trained to provide installations meeting the product manufacturer's requirements for a minimum of 20 year guaranteed system.
      b. Length of time every technician has been employed in the telephone, data and fiber optic structured cabling installation business.
      c. Length of time every technician has been employed by the Company.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt of Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cables for continuity.

1.11 PROTECTION

A. Until final acceptance of work, Contractor shall protect all materials and equipment from damage.
   1. Any components stored or installed on-site shall be protected with a minimum polyethylene or equivalent covering to protect from moisture, plaster, cement, paint, or other work of other trades.
   2. Contractor is responsible to protect Owner's furnishings from damage due to their activities in occupied spaces and to clean up any debris created as a result of their work.

1.12 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA/NFPA 70 and NECA/BICSI/TIA standards.

B. Provide connectivity and cabling manufacturers that are top tier premium partners with established publicly recognized cooperative alliance offering a joint warranty (minimum of 20 years).

2.02 CABLE PATHWAY AND SUPPORTS

A. General Requirements: Comply with ANSI/TIA-569-D.

B. Cable Support: NRTL labeled for support of fiber optic cabling. Cable support brackets shall be bridal rings or loop supports designed to prevent degradation of cable performance and pinch points that could damage cable. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.

C. Cable Tray: Installation methods and material specifications of cable tray shall be governed by Division 26 05 36 specifications. Route all cables direct to cable tray and run cables in cable tray where provided.

D. Provide waterfalls for transition points such as telecommunications room entrance to ladder rack and from ladder rack to rack. Waterfalls shall provide support and manage bend radius.

E. UL Listed Fire-rated Pathway: Provide fire rated riser and horizontal pathways in configurations and locations as shown on the drawings or where required to pass cabling through fire rated floors or walls. See Architectural code plan for locations of fire rated partitions. Follow all manufacturer's recommendations to provide a UL listed installation with an 'F' rating that matches that of the partition. Provide EZ-Path by Specified Technologies (STI) or equal.

2.03 FIBER OPTIC CABLE

A. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
   1. Belden
   2. Berk-Tek
   3. CommScope
   4. Corning
   5. General Cable Co.
   6. Mohawk
   7. Panduit
   8. Siemon
   9. Superior Essex

B. Description:
   1. Multimode 50/125 µm, laser-optimized (OM4)
      a. Shall be capable of providing 1 Gb/s at a distance of 880m at 850 nm and 1 Gb/s at a distance of 550m at 1300
      b. Shall be capable of providing 10 Gb/s at a distance of 450m at 850 nm and 10 Gb/s at a distance of 220/300m at 1300 nm.
      c. Shall be tested in accordance with TIA-455 FOTPs and independently certified by ETL or UL.
      d. Sheath shall be color-coded to optical fiber type and printed with relevant cable information on cable.
      e. Shall have interlocking aluminum armor
      f. Shall have industry standard buffer tubes stranded around a central strength member and compatible with standard hardware, cable routing, and fan-out kits.
      g. Shall be industry-standard color coded and separated in 12-fiber color-coded binder groups surrounded by plastic core tubes.
      h. Shall comply with ICEA S-83-596 for mechanical properties
      i. Shall comply with ANSI/TIA-568.3-D for performance specifications.

j. Jacket Color shall be Aqua
k. Cable cordage jacket, fiber, unit, and group color shall be according to ANSI/TIA-598-C.
l. Shall be imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).
m. Shall meet National Electric Code OFCP rated insulation and jacket material as required for specific installation.
n. Strand count as identified on detail page on drawings.

2.04 OPTICAL FIBER CABLE CONNECTING HARDWARE

A. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
1. Belden
2. CommScope
3. Corning
4. Leviton
5. Ortronics
6. Panduit

B. Description:
1. Connectors
a. Shall comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-XX
b. Shall comply with ANSI/TIA-568.3-D
c. Shall have an operating temperature range of -10° C to 60° C (14° F to 140° F).
d. Shall be fusion spliced
e. Style shall be LC
f. Shall match and be compatible with the fiber mode and type of cable provided
g. Insertion loss shall not exceed 0.2dB per connector for both multimode and single mode
h. Color shall match the style of cable provided
2. Patch Panels, Trays and Enclosures
a. Shall comply with ANSI/TIA-568.3-D
b. Shall be standards based 19-inch rack mountable
c. Provide cable management for proper slacking and spooling
d. Shall be constructed of high strength steel
e. Shall have integrated labeling system or space for port identification
f. Shall have front cover. Provide blanks for all unused ports.
g. Provide capacity to exceed total backbone fiber strands by 100%

2.05 FIBER OPTIC PATCH CABLES

A. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
1. Belden
2. CommScope
3. Corning
4. Leviton
5. Ortronics
6. Panduit
7. Siemon

B. Description
1. All fiber patch cables shall be factory-made and factory-tested.
a. -50 dB maximum
b. -4 to +158 deg. F.
c. $\mu = 0.35$ dB, $\sigma = 0.2$ dB
d. 50 lb. (220 N) minimum
e. 0.20 dB maximum change per 100 reconnects

2. Multi-Mode Fiber Optic Patch Cables:
    a. Shall consist of dual buffered, graded-index fiber matching the rating of the cable provided
    b. Shall have a 50 µm core and a 125 µm cladding covered by aramid yarn and a jacket of flame-retardant PVC and be laser optimized OM4
    c. Shall be terminated with LC-duplex both ends
    d. Shall be aqua in color
    e. Shall be furnished in manufacturer-sealed bags
    f. Verify lengths with Owner prior to placing product order
    g. Quantity: Furnish quantity to patch end-to-end **100%** of fiber strands provided.
    h. Shall be furnished in manufacturer-sealed bags
    i. 2 to 3 meters in length.

2.06 LABELING

A. General Requirements:
    1. Shall comply with ANSI/TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers
    2. Labeling stock shall support laser printing and have a clear overwrap
B. Manufacturers" Subject to compliance with the requirements, provide products by one of the following:
    1. Panduit
    2. Approved equal

2.07 CABLE PATHWAY

A. UL Listed Fire-rated Pathway:
    1. Provide fire rated riser and horizontal pathways in configurations and locations as shown on the drawings or where required to pass cabling through fire rated floors or walls.
    2. Refer to Architectural code plan for locations of fire rated partitions.
    3. Follow all manufacturer's recommendations to provide a UL listed installation with an 'F' rating that matches that of the partition.
    4. Approved Manufacturers:
        a. EZ-Path by Specified Technologies (STI)
        b. Approved equal
B. Smoke and Acoustical Pathway:
    1. Provide acoustical rated pathways in configurations and locations as shown on the drawings or in noise sensitive areas with cable penetration.
    2. Approved Manufacturers:
        a. EZ-Path Series 44NEZ by Specified Technologies (STI)
        b. Approved equal

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Common work for communications backbone cabling systems shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2015 and ANSI/NECA/BICSI 568-D, Standard for Installing Commercial Building Telecommunications Cabling latest edition is hereby adopted to define such workmanship and the installation of communications horizontal cabling.

3.02 EXAMINATION

A. Test cables upon receipt at Project site
    1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
    2. Test optical fiber cable while on reels. Use an optical time domain reflectometer (OTDR) to verify the cable length and locate cable defects. Retain test data and include the record in maintenance data.
B. Examine products before installation. Reject products that are moisture damaged or physically damaged.
C. Examine elements and surfaces for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 SYSTEM INSTALLATION

A. General Wiring Methods

1. Each respective Backbone Cable shall be routed continuously, vertically and horizontally, between Telecommunications Rooms as indicated in the detail drawings or described within this specification.
2. All cables are to run at right angles to the structure.
3. Cable shall not be run through structural members, elevator shafts, or in contact with pipes, ducts, or other potentially damaging items.
4. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
5. Do not exceed recommended pulling tensions. Comply with BICSI ITSIM for proper pulling tensions.
6. Install backbone cabling in raceways and cable trays where provided.
7. Where cables leave the cable tray, they shall be independently supported by cable supports/loops.
    a. All wire and cables shall be supported at least every 5 feet from the structure or as required to maintain no more than 12” sag between supports and without over-tensioning the cables.
8. Cables shall not be supported on ceiling support systems, water, gas, or any other utility system.
9. Conceal raceway and cables except in unfinished spaces.
10. In exposed areas, route cables in conduit.
11. All cabling routed through walls or floors shall be installed in a conduit sleeve of appropriate size for cables installed.
    a. Conduit sleeve shall include plastic bushing on each end.
    b. Conduit sleeve shall be neatly installed and wall shall be patched if broken out on either side.
    c. In areas using existing penetrations not sleeved, provide split sleeve protection.
12. Provide conduit in areas where cables could be subject to physical damage (i.e. mechanical, storage, gymnasium, electrical rooms, etc.).
    a. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
    b. Do not install bruised, kinked, scored, deformed, or abraded cable. Discard cable if damaged during installation and replace it with new cable.
13. Cable terminations shall be in accordance with manufacturer’s installation instructions and industry guidelines.

B. Installation of Optical Fiber Cable

1. Install cable without damaging fiber or jacket. Do not bend fiber optic cable to a smaller radius than minimum recommended by manufacturer. Do not exceed manufacturer’s recommended pulling tensions.
2. Splicing of fiber optic cabling is unacceptable except where indicated on the plans.
3. Where cabling is routed vertically, it shall be appropriately secured such that the weight of the cabling does not subject the cabling to stresses that could potentially reduce the performance of the cabling.
4. Wiring in Telecommunications Rooms, Racks and Cabinets:
    a. All cable shall be fully supported and properly transitioned throughout their lengths, including proper bend radius fittings in pathway transitions.
    b. Install cable in cable tray or ladder rack where provided.
    c. Bundle, lace, and train the fiber optic cable and terminate on fiber termination enclosure using manufacturer’s installation procedures.
    d. Provide and use wiring management.
    e. Hook and loop straps (Velcro) shall be the only method for bundling (zip ties are not acceptable. The straps shall not be tightened to the point of compressing the cables. Provide hook and loop straps every 24”.
    f. Connect to terminal points with no excess and without exceeding manufacturer’s limitations on bending radii.
    g. Provide 10 foot maintenance loop of fiber optic cable in ladder rack prior to dropping into rack.
5. Armored fiber shall be bonded to ground in accordance with national or local code requirements.

C. Installation of Fiber Optic Cable Patch Panel
   1. The fiber optic patch panels shall be installed in the top space of the rack unless shown otherwise in detail drawings.
   2. Prepped fiber cable slack shall be neatly coiled within the fiber termination panel. No prepped slack loops shall be allowed external to the fiber panel(s).
   3. Each cable shall be individually attached to the respective termination panel by mechanical means. The cable's strength member(s) shall be securely attached to the cable strain relief bracket in the panel.
   4. Each fiber cable shall be stripped upon entering the termination panel and the individual fibers routed in the termination panel.

D. Conduit Pathway
   1. No single bend shall be greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
   2. No section shall exceed 100 ft. in length. Pull points or pull boxes shall be inserted so that no segment between points or boxes exceeds the 100 ft. limitation.
   3. Bond to ground on one or both ends in accordance with national or local code requirements.
   4. Shall not run over or adjacent to heat sources such as boilers, incinerators, hot water lines, or steam lines.
   5. Each conduit shall have a pull string tied off at both ends.
   6. All conduit ends shall be reamed and fitted with a suitable bushing.
   7. Flex conduit shall not be used within walls, ceilings, or counters without prior approval.

3.04 DEMOLITION

A. Where demolition is indicated on drawings or project documents, Contractor shall be responsible for removal, collection, transportation, and disposal of all indicated cabling and components.

B. Removal shall consist of all components from end termination point to termination point of origin, unless noted otherwise.

C. Contractor shall field-verify existing conditions prior to beginning demolition work. All discrepancies between existing conditions and specifications or drawings shall be reported to the Architect prior to the start of work in order to prevent disturbance of existing installations. Beginning work shall indicate acceptance of existing conditions. Contractor is responsible for immediately restoring any outages caused as a result of removing or damaging adjacent cabling, systems, or services.

D. If the Contractor removes anything from an opening in a fire-rated wall, the Contractor shall restore the fire-rating condition of the wall to the same condition as before the Contractor started its work. Depending on the size of opening, this may involve sheetrock patching, in addition to use of other appropriate fire-stopping materials.

3.05 PENETRATIONS OF STORM SHELTER ENVELOPE

A. Penetrations through the storm shelter envelope larger than 3 ½ square inches (2258 mm2) in area rectangular penetrations or 2 1/16 inches (52.38 mm) in diameter, shall be considered openings and shall be protected in accordance with Chapter 3, Section 306.3 of ICC 500.

3.06 FIRESTOPPING

A. Contractor shall be responsible for firestopping all wall and floor/ceiling penetrations and pass-throughs designated for technology use. Firestopping method shall meet or exceed the minimum rating of wall, ceiling or floor penetrated.

B. Comply with requirements in Division 07 Section "Penetration Firestopping."

C. Comply with ANSI/TIA-569-D, Annex A, "Firestopping."

D. Comply with BICSI TDMM, Chapter 7: Firestop Systems.

3.07 FIRESTOPPING

A. Contractor shall be responsible for firestopping all wall and floor/ceiling penetrations and pass-throughs designated for technology use. Firestopping method shall meet or exceed the minimum rating of wall, ceiling or floor penetrated.

B. Comply with ANSI/TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, Chapter 7: Firestop Systems.

D. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, adds, and changes will occur.
E. Where non-mechanical products are utilized, provide products that upon curing do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
F. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
G. Openings for cable trays shall be sealed using re-enterable fire stopping pillows.

3.08 CAULKING

A. The Contractor shall be responsible for caulking wall and floor/ceiling penetrations that are not through fire rated barriers. The caulking shall provide acoustical separation by applying a sound barrier to the penetration.

3.09 GROUNDING AND BONDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors and Division 27 as indicated herein.
B. Comply with ANSI/TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
C. Ground all equipment per manufacturer's recommendations, BICSI TDMM and ANSI/TIA guidelines, NEC codes, and all other applicable code and regulations.
D. Bond all non-current carrying metallic equipment to the grounding bus bar. Equipment grounding conductor to be no smaller than No. 6 AWG.

3.10 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-B. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Administration Class: 1
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, and equipment grounding conductors.
D. Cable and Wire Identification:
   1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Backbone cables, both fiber optic and copper, shall be labeled every 50 feet throughout the length of the cables. The labels shall designate the origin and destination of the cable.
E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA-606-B. P-Touch labeling and similar labeling equipment is not acceptable.
F. Reference BICSI TDMM, Chapter 10 – Telecommunications Administration for general information.
G. Confirm final labeling scheme with Technology Designer and Owner prior to installing labels. Labeling practices shall be consistent throughout the project.

3.11 FIELD QUALITY CONTROL

A. Inspections:
   1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding and inspect cabling connections for compliance with ANSI/TIA-568.3-D.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

B. Testing:
   1. General:
      a. All final test results shall be submitted to the Technology Designer for verificationFinal test results shall be machine generated and submitted within 30 working days of completion for each phase of the project. Hand written data is not acceptable for the final version.
      b. All test results shall be submitted to Owner in electronic form, both in PDF form and the original test result data files.
      c. Contractor shall be required to retain a copy of the test reports for a period of at least 5 years after installation.
      d. Testing shall be performed with equipment that has been calibrated in accordance with the manufacturer's specifications as well as factory calibrated within one year prior to being utilized to perform the tests herein.
      e. All installed cables and termination hardware shall be tested 100% for defects to verify cabling system performance under installed conditions is in accordance with the applicable TIA standards.
      f. Record results of the test with cable identification and provide as part of the As-Built documents and cable management software. Any cable that fails shall be re-terminated and retested. If the cable fails the additional testing, the cable shall be replaced and retested.
      g. Record the test data records to the cable management software database. Database shall be loaded with each strand or individual copper cable, telecommunications room or enclosure, general path, and cross connects completed by Contractor for the entire physical layer installation.
      h. Tests shall be performed after permanent labeling has been installed on cables and termination points. Permanent labeling nomenclature shall be used for identification in the testing process.
      i. Perform testing as described in ANSI/TIA-568-D and all published Annexes per the backbone media installed.
      j. Test information along with manufacturer and model number of test equipment shall be included as part of the project As-Built documents. Submit final test reports after approval from the Engineer to the manufacturer of the certified cabling system for warranty of the system. Provide a copy of the material provided by the manufacturer indicating acceptance and warranty of the system. Provide originals to the Owner and train Owner on the procedures for receiving future warranty work.
      k. Upon Owner or Technology Designer request for verification of documented findings, provide a random field re-test on 10% of the cable system at no additional cost. In the event that the random field re-test reveals contradictory information from the original test documents, re-testing shall be provided up to 100% of the cabling system provided as part of this project. Documentation included in the As-Built documents shall include all failed test results as well as the passed test results after corrections were made.
   2. Cable Test Reports:
      a. Shall be automatically produced by the test equipment
      b. Shall indicate that the cable passed the test.
      c. Shall indicate the date of calibration, the software version, and the name of the technician who conducted the test.
      d. Shall include graphical results of the performance curves obtained during the testing
      e. Shall indicate that the cable test equipment was properly configured.
      f. Shall include the cable identifier that matches final and Owner approved nomenclature.

3. Fiber Optic Cable
    a. Fiber Testing:
        1) Optical fibers shall be individually tested with connectors attached. A Fiber Transmission Loss Test shall be performed after connectors are installed and interconnection has been completed
        2) Testing shall include: attenuation, attenuation uniformity, end-to-end continuity, transmission loss tests to assure decibel (dB) losses are within budget levels, length, and other cabling tests normally performed.
        3) Each cable span shall be tested individually.
        4) Tests shall be conducted selectively after cross-connection of the cable spans.
        5) Cabling performance characteristics shall meet or exceed the performance guaranteed by the manufacture, which may exceed standard industry requirements. Any link not meeting the requirements of the standard shall be brought into compliance by the subcontractor, at no charge to the Owner.
        6) Fiber testing shall be performed on all fibers in the completed end-to-end system (link test).
        7) Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
        8) The system loss measurements shall be provided at both wave lengths, 1310 nm and 1550 nm for single mode fiber and 850 nm and 1300 nm for multimode fiber, and both directions.
        9) Each measured and calculated loss shall be recorded in an Optical Fiber Transmission Loss Measurement Table. The table shall be provided on hard copy and on an electronic media format desired by Owner.
    b. Fiber Test Equipment:
        1) The equipment shall be Optical Loss Test Set (OTLS) field-test equipment approved by fiber manufacturer, Level IV or higher, Optical Time Domain Reflectometer (OTDR) (e.g. Fluke DTX or DSX), and meets or exceeds applicable requirements in ANSI/TIA-568.3-D.
        2) The equipment utilized for testing shall be an optical source and optical power meter capable of testing multimode optical fiber at 850 nm and 1300 nm and single mode at 1310 nm and 1550 nm.
        3) Contractor shall be required to perform end-to-end attenuation testing with a VCSEL laser transmission source, or similarly approved equipment to ensure compliance with attenuation limits.
        4) Test equipment shall be calibrated per manufacture's recommendation. Proper procedures shall be followed to calibrate the device(s). Calibration information shall be provided with test results in the As-Built documents.

3.12 ADJUSTING, PROTECTION, AND CLEANING

A. Upon completion of installation of communications backbone pathways, clear all blockages and remove burrs on pathways, splatters, and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

B. Provide final cleaning, protection, and maintain conditions in a manner acceptable to manufacturer, which ensures system being free from damage and deterioration at time of Substantial Completion.

3.13 WARRANTY

A. Installation Contractor's Warranty:
    1. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Warranty period shall begin on the date of acceptance as issued by the Architect's certificate of completion.

2. Installation Contractor's Warranty shall cover:
    a. Workmanship and craftsmanship, ensuring that the system is installed in compliance with Industry Standards, manufacturer requirements, and the requirements of the construction contract.
    b. Product defects.
    c. Components that do not meet or exceed the specifications of ANSI/TIA-568.3-D Optical Fiber Transmission/Test Requirements.
    d. Failure of the installed structured wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA-568-D series of Telecommunication Standards

B. Systems Warranty:
1. In addition to the Installation warranty, a systems warranty shall be provided.
2. The Contractor shall guarantee all materials and equipment for a minimum of one year from date of substantial completion of this work. This guarantee shall include all labor, material, and travel time.
3. In addition, provide the longest available manufacturer's warranty, not to be less than 20 years. This shall be the Manufacturer's warranty covering a system installation of premium partner products.
4. Manufacturer's Warranty shall cover:
    a. Product defects.
    b. Components that do not meet or exceed the specifications of ANSI/TIA-568.3-D cabling links and channels.
    c. Failure of the installed structured wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA-568.3-D component and link/channel specifications for cabling.
5. Contractor shall provide in the As-Built documents the numbered certificate from the manufacturing company showing registration of the installation.

END OF SECTION 27 13 00

SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Introduction:
   1. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of a completely operational communications horizontal cabling system as shown, required, and specified herein. The omission of express reference to any items or work necessary for, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor from providing such items or work.

B. Scope and Intent:
   1. Renovation at the Nelson Care Center by Vivie**.** Project scope includes, but is not limited to, demolition of some existing horizontal cabling, provision of new horizontal cabling.
   2. This section includes installation, testing, documentation and training to provide a fully functional, manufacturer certified Gigabit per second (Gbps) telecommunications data cabling system. wireless access points and camera locations that comply with transmission standards in ANSI/TIA-568-D.
   3. This section includes installation of Coax cabling and associated terminations.

C. This Section Includes:
   1. Pathways
   2. UTP cable
   3. Coax Cable
   4. Patch cables
   5. Station cables
   6. Cable connecting hardware, patch panels, and cross-connects
   7. Telecommunication Outlet assemblies, faceplates, and frames
   8. Wireless Access point wire and connectivity
   9. Surveillance camera wire and connectivity
   10. Video intercom and master station data cabling.
   11. Cabling identification products
   12. Testing

1.02 RELATED DOCUMENTS

A. The following sections, along with this section, provides a structured cabling system as shown on the drawings
   1. Common Work Results for Communications (Section 27 05 00)
   2. Communications Equipment Room Fittings (Section 27 11 00)
   3. Communications Backbone Cabling (Section 27 13 00)

1.03 DEFINITIONS

A. 8P8C – Eight Position, Eight Contact
B. A/V – Audio Visual
C. AWG – American Wire Gauge
D. CMP – Communications Plenum (cable)
E. EMI – Electromagnetic Interference
F. Gbps – Gigabit per second
G. HVAC – Heating, Ventilation, and Air Conditioning
H. IDC – Insulation Displacement Contact
I. ITSIMM – BICSI's Information Transport Systems Installation Methods Manual
J. MUTOA – Multi-user Telecommunications Outlet Assembly
K. RCDD – Registered Communications Distribution Designer
L. RU – Rack Unit
M. STP – Shielded twisted pair
N. TDMM – BICSI's Telecommunications Distribution Methods Manual

O. TO – Telecommunication Outlet
P. UTP – Unshielded Twisted Pair
Q. WAP – Wireless Access Point

1.04 REFERENCES

A. The products provided by this section shall comply with the following applicable references and standards (latest edition):
   1. ANSI/TIA Telecommunications Building Wiring Standards:
      a. ANSI/TIA-568-D: Generic Telecommunications Cabling for Customer Premises, Commercial Building Telecommunications Cabling Standard, Balanced Twisted-Pair, Fiber Optic Cabling Components Standard, and Components Standard .
      b. ANSI/TIA-569-D: Telecommunications Pathways and Spaces.
      c. ANSI/TIA-606-B: Administration Standard for Commercial Telecommunications Infrastructure.
      d. ANSI/TIA-607-D: Generic Bonding and Grounding (Earthing) for Customer Premises.
      e. ANSI/TIA-1152-1 Requirements for Field Test Instruments and Measurements for Balanced Twisted Pair Cabling.
   2. NFPA 70 National Electrical Code
   3. BICSI Telecommunications Distribution Methods Manual
   4. BICSI Information Technology Systems Installation Methods Manual

1.05 INSPECTION OF SITE BEFORE CONSTRUCTION:

A. Pre-Installation Meeting:
   1. Arrange for pre-construction meetings to coordinate installation of structured cabling system with Owner's representative including but not limited to, facilities staff, maintenance, IT, and administrative staff. The Architect's Technology Designer shall be included in these meetings.
   2. Meeting shall include review of entire installation, including locations of equipment, layout of equipment in spaces, labeling schemes, features, functions, capabilities, and integrations.
   3. Review phasing of systems through the duration of the project.
   4. Take attendance and minutes and submit with the close out documents.
B. Construction Meetings:
   1. Attend construction meetings for coordination with other disciplines and trades.

1.06 COORDINATION

A. Coordinate layout and installation of communications horizontal cabling with cable tray installation and work area station locations.
B. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.07 EXISTING CONDITIONS

A. This is an active facility with a phased construction and demo approach. Contractors will maintain connectivity in all active areas and shall pay attention during demo as not to disconnect active connections. All existing backbone connectivity shall be maintained until new backbone has been installed and cutover.
B. Boiler Room TR rack will be demoed. It contains 123 data cables, it serves data locations where renovation is not planned for. However, to completely demo this TR rack, those cables will need to be replaced as part of this contract. Contractor will demo all cables that are part of the planned construction demo to this TR, while maintaining the existing active data connections going to this TR that are serving outside of renovation area. After the new TR (A124) is established, the contractor will pull new data cables from new TR to all locations outside of the renovation area that this Boiler room TR served. These locations outside of the renovation area will be active and will require cables to be pulled while existing is in place, terminated on the new TR side, then cut over on the user end from the old cabling/jacks to the new and patched. Contractor will use new jacks and faceplates for these replacement terminations. After the cutover, demo existing cabling back to boiler room TR and remove rack and associated rack components. Contractor to plan for proper labor for cutover to new cabling in a phased approach to lesson active residence impact. This includes working with IT to re-establish/patch connectivity.

C. All Coax Tap locations throughout the facility will be maintained and will be used for any new cabling.
D. There are two areas that have hard deck ceilings. Main entry in the admin area and long hallway between B124 closet and Server Room C closet. Additional labor and material will be required to accommodate these areas.

1.08 SUBMITTALS

A. Shop Drawings shall be submitted for approval for all communications horizontal cabling components prior to commencing installation. Refer to specification section 01 for additional information on form and content of submittals
   1. Provide a complete materials list, listing quantity, manufacturer, model number and description of the system components listed below
   2. Provide a manufacturer's specification sheet for the system components listed below. Identify the actual part numbers to be utilized using highlights, arrows, or clouds.
   3. System components:
      a. Pathway components
      b. Patch Cables
      c. Station Cables
      d. Patch Panels
      e. UTP Cable
      f. Coax cable
      g. Work Area Outlets (Jacks, Plates, and Frames)
      h. Surface mount boxes (biscuit jacks)
   4. Provide system diagrams
      a. Rack layouts
      b. Work Station Telecommunications Outlet Assemblies
   5. Provide samples of any or all proposed system components requested for examination/approval.
   6. Provide a sample of labeling scheme and method.
   7. Provide qualification documents as described in the quality assurance section.
      a. Manufacturer certification credentials of staff assigned to project for installation or a BICSI equivalent certification
      b. RCDD credentials for staff assigned to supervise this project. In the event that the assigned RCDD changes during the course of this project, credentials for the newly assigned RCDD shall be submitted to the Technology Designer.
      c. Manufacturer's certification indicating capability to provide a minimum of 20 year warranted system
      d. Low voltage licensure credentials of staff assigned to project for installation
B. As-Built Documents shall be submitted for approval for all communications horizontal cabling components listed below. Refer to specification section 01 for additional information on form and content of submittals. Include the following documents:
   1. As-Built Drawings showing locations of all devices and cable routing on complete floor plans of 1/8" scale. Devices shall be indicated by their final label identifier. Handwritten data is not acceptable.
   2. Equipment cabinet layouts
   3. Labeling schemes and schedules
      a. Electronic copy of labeling schedules in software and format selected by Owner
      b. Define the format selected by Owner. Include an example label with each component described. Refer to Part 3 Identification for additional information.
      c. Cabling administration drawings and printouts
   4. Operation and Maintenance manuals
   5. Manufacturer's required maintenance related to system warranty requirements
   6. Cable test result documentation by a tester calibrated within the last 12 months.
   7. Testing equipment's calibration test results by a certified laboratory or the manufacturer within the last 12 months, and such certification along with the device serial number.
   8. Record of Warranty

1.09 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Provide connectivity and cabling products from manufacturers that are top tier premium partners offering the longest available warranty from the manufacturer (minimum of 20 years).

B. Product Qualifications:
   1. Provide materials listed by UL or ETL.

C. Contractor Qualifications:
   1. Minimum of five years local experience installing telephone, data and fiber optic structured cabling systems.
   2. Two structured cabling system networks installed locally and operating for a minimum of one year.
   3. Local support center.
   4. Place of business that locally maintains the necessary spare parts in the proper proportion to this project, as recommended by the manufacturer, to maintain and service the equipment supplied.

D. Project Installer Qualifications:
   1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of an RCDD, BICSI Certified Technician, or Manufacturer's Certified Technician. Supervisor shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as a Certified Installer or industry acceptable equivalent to supervise on-site testing. RCDD shall conduct a site visit to inspect installations a minimum of once a week
   4. Installers: Certified by manufacturer of product(s) installed or have equivalent BICSI certification.
   5. Capability to provide a minimum of 20-year Manufacturer's warranty from a specified Manufacturer.

E. Provide, upon request, Contractor information as follows:
   1. Period of time Contractor has installed similar systems.
   2. List of all similar systems installed locally within the last five years, indicating the following:
      a. When system was installed.
      b. Name and telephone number of reference person for each system.
   3. Description of installation capabilities, indicating the following:
      a. Number of local technicians trained to provide installations meeting the product manufacturer's requirements for a minimum of 20 year guaranteed system.
      b. Length of time every technician has been employed in the telephone, data and fiber optic structured cabling installation business.
      c. Length of time every technician has been employed by the Company.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt of Project site. Test each pair of UTP cable for open and short circuits.

1.11 PROTECTION

A. Until final acceptance of work, Contractor shall protect all materials and equipment from damage.
   1. Any components stored or installed on-site shall be protected with a minimum polyethylene or equivalent covering to protect from moisture, plaster, cement, paint, or other work of other trades.
   2. If during shipment or installation, finish or equipment becomes chipped or scratched, Contractor shall touch up or refinish surfaces to match original finish or replace if necessary.
   3. Contractor is responsible to protect Owner's furnishings from damage due to their activities in occupied spaces and to clean up any debris created as a result of their work.

1.12 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION

A. All electrical equipment and material shall be new and bear a recognized testing laboratory's label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 and NECA/BICSI/TIA standards.

B. Provide connectivity and cabling manufacturers that are top tier premium partners offering the longest available installation warranty (minimum of 20 years).

2.02 HORIZONTAL CABLE

A. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
   1. Belden
   2. Berk-Tek
   3. CommScope
   4. General Cable Co
   5. Leviton
   6. Mohawk
   7. Panduit
   8. Siemon
   9. Superior Essex

B. Description:
   1. Category 6:
      a. 4-pair Unshielded Twisted-Pair (UTP) cable
      b. ANS/TIA-568-C.2 Category 6 compliant
      c. UL verified Category 6
      d. Cable transmission performance indicated on cable outer jacket
      e. National Electric Code CMP rated insulation and jacket material
      f. Cable shall be factory tested according to ANSI/TIA-568- C.2
      g. 23 or 24 AWG solid copper conductor.
      h. Below-grade cables shall be outside plant rated cables. Cables shall have polyethylene jackets and water stopping material or similar materials to protect from long-term exposure to water.
      i. Color shall be blue
      j. Use for typical telecommunications outlet, tv outlets, wireless access point locations and video intercom/master station locations.
   2. Coax:
      a. RG-6 Quad Shield
      b. UL listed.
      c. Cable transmission performance indicated on cable outer jacket.
      d. National Electric Code CMP rated insulation and jacket material
      e. Cable shall be factory tested
      f. 18 AWG solid copper clad steel conductor.
      g. 75 Ohm.
      h. Color shall be white
      i. Use for typical TV outlets.

2.03 TERMINATION EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden
   2. CommScope
   3. Hubbell
   4. Leviton
   5. Ortronics/Legrand
   6. Panduit
   7. Siemon

B. Modular Patch Panels
   1. Description:
      a. 19-in. wide for rack mounting
      b. Modular to accept individual keystone style data jacks
      c. Shall be constructed of high strength steel with black powder finish
      d. Shall be available in 24-port and 48-port configurations with height of 1 or 2 RUs of 1.75" for each group of 24 ports.
      e. Integrated labeling system or space for port identification
   2. Provide:
      a. Patch panels shall provide space for 115% of the total number of terminated jacks at each telecommunications room.

C. Surface Mount Box (Biscuit Jack)
   1. Description:
      a. Shall accept data jacks from same manufacturer.
      b. Shall have mounting options of screws or adhesive
      c. Shall have integrated labeling system
      d. Shall have capability of accepting two (2) data jacks
      e. Color shall be electric ivory
   2. Provide:
      a. Refer to drawings to determine quantity for Wireless Access Point and Surveillance Camera locations.
      b. Number of jacks as indicated on drawings
      c. Number of blanks as indicated on drawings.

D. Coax inserts:
   1. Description
      a. Shall be F female coupler.
      b. Shall be keystone designed for use with data faceplates (data and coax will share feaceplate)
      c. Shall match color of faceplate
   2. Provide:
      a. Refer to drawings to determine quantity for TV locations.
      b. Headend location will use connector only and will screw directly to tap. Headend locations are existing and may not necessarily be in established data closets.

E. Data Jack Modules
   1. Description:
      a. Category 6
         1) 8-pin 8-conductor modular jack module compliant per ANSI/TIA-568-C.2
         2) Exposed performance marking on jacks shall identify the category
         3) 110 Type IDC connection for horizontal cable termination on back
         4) UL 1863 approved
         5) Provide wire/dust cap
         6) Jack modules shall universally fit into same manufacturer's patch panels and telecommunications outlet assemblies
         7) One manufacturer's product line shall be used for all terminations at both telecommunications' outlet assembly and telecommunications room.
         8) Color shall be as follows:
            (a) Data – Blue
            (b) Verify colors prior to ordering
      b. **Coax connector**
         1) RG-6 F connector.
         2) Shall be rated/designed for terminating to quad shield plenum cabling
         3) Shall be compression style terminations.
         4) One manufacturer's product line shall be used for all terminations at both telecommunications

2. Provide:
    a. Refer to drawings to determine quantity

2.04 TELECOMMUNICATIONS OUTLET ASSEMBLIES

A. Manufacturers:
1. Belden
2. CommScope Uniprise
3. CommScope Systimax
4. Leviton
5. Ortronics/Legrand
6. Panduit
7. Siemon

B. Modular Face Plates
1. Description:
    a. ABS Plastic
    b. Designed for flush wall mounted outlets
    c. Shall be available in 1- and 2-gang configurations
    d. Shall NOT be 106 style
    e. Shall have integrated labeling system that includes identification windows on top and bottom of plate. The window shall have a snap-in clear plastic cover to protect labeling strip.
2. Provide:
    a. Refer to drawings to determine quantity, sizes, and number of module ports.
    b. Shall be light almond – match electrical plates – verify color with Div 26 prior to ordering.

C. Frames
1. Description:
    a. All frames shall be compatible with the faceplate and modules provided.
    b. All frames shall manually snap or screw into faceplates of the same manufacturer
    c. All frames shall be manufactured from high-quality ABS plastic.
    d. Shall NOT be 106 style
    e. Color shall match plate. If plate is stainless steel, provide gray or match other frames in the room.
2. Provide:
    a. As needed to provide a solution compatible with the Owner's equipment. Refer to drawings and details for additional information.

D. Wall-Mounted Telephone Outlets:
1. Description:
    a. Stainless steel faceplate

2.05 PATCH CORDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following and shall match warranty system:
1. Belden
2. CommScope Uniprise
3. Hubbell
4. Leviton
5. Ortronics/Legrand
6. Panduit

B. Telecommunications Room Patch Cables
1. Description:
    a. Category 6**,** 4-pair 24 AWG, UTP cable with 8-position 8-conductor Modular Plug at each end and wired straight through with standards compliant wiring.
    b. Snagless booted design
    c. UL listed per United States Standards
    d. 100% factory-assembled

e. 100% transmission tested with laboratory grade network analyzers for proper performance
f. Lengths of patch cords shall comply with ANSI/TIA 568-C.2 recommended
g. Color: Blue: Verify color prior to ordering

2. Provide:
a. **100** percent of the total number of ports terminated on patch panels
b. 100% - 9”

C. Workstation Patch Cables
1. Description
a. Category 6 4-pair 24 AWG, UTP cable with 8-position 8-conductor Modular Plug at each end.
b. UL listed
c. 100% factory-tested
d. Lengths of patch cords shall comply with ANSI/TIA 568-C.2 recommended
e. Color: Blue: Verify color prior to ordering.

2. Provide:
a. 100 percent of the total number of data communication outlets
b. 40% - 5 ft.
c. 50% - 10 ft.
d. 10% - 15 ft.

2.06 CABLE PATHWAYS AND SUPPORTS

A. Description:
1. Cable supporting systems shall bundle and support cabling in open support systems.
2. Provide, install, and comply per TIA-569-D.

B. Cable Support:
1. NRTL labeled for support of Category 6 cabling.
2. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable.
3. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
4. Support brackets with cable tie slots for fastening cable ties to brackets.
5. Cable supports shall include, but not be limited to, lacing bars, spools, and J-hooks.
a. J-Hooks shall:
1) Be steel, UL listed, and shall have an ultimate static load limit of 50 lbs. minimum
2) Have a wide base with beveled edges
3) Be rated to support Category 5 and higher cables as well as optical fiber cables
4) Be used where cable tray is not provided
b. Flexible Non-Metallic Cable Support shall:
1) Be white plastic, UL listed, and shall have an ultimate static load limit of 25 lbs. minimum.
2) Rotate for versatile mounting
3) Be rated to support Category 5 and higher
4) Be used where cable tray is not provided
6. Cable support system shall include, but not be limited to, straps, beam clips, flange clips, drop wire/rod, C and Z purlin clips, and other devices.
7. Approved Manufacturers:
a. Arlington
b. B-Line
c. Caddy
d. Erico
e. Panduit

C. Cable Management:
1. Supply plenum rated hook and loop straps for cable management in the pathway
2. Provide, length and strength as required to properly organize and bundle cable
3. Plastic tie-wraps are unacceptable

4. Provide plenum-rated straps in plenum spaces
5. Approved Manufacturers:
    a. Velcro
    b. Approved equal

D. UL Listed Fire-rated Pathway:
1. Provide fire rated riser and horizontal pathways in configurations and locations as shown on the drawings or where required to pass cabling through fire rated floors or walls.
2. Refer to Architectural code plan for locations of fire rated partitions.
3. Follow all manufacturer's recommendations to provide a UL listed installation with an 'F' rating that matches that of the partition.
4. Approved Manufacturers:
    a. EZ-Path by Specified Technologies (STI)
    b. Approved equal

E. Smoke and Acoustical Pathway:
1. Provide acoustical rated pathways in configurations and locations as shown on the drawings or in noise sensitive areas with cable penetration.
2. Approved Manufacturers:
    a. EZ-Path Series 44NEZ by Specified Technologies (STI)
    b. Approved equal

F. Conduit and Boxes:
1. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems"
2. Flexible metal conduit shall not be used.

2.07 IDENTIFICATION PRODUCTS

A. Comply with ANSI/TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Exposed labels shall be tamper-resistant material.

2.08 EXTRA MATERIALS

A. Furnish extra materials that match products installed. All extra materials shall be packaged with protective covering for storage and identified with labels describing contents.
1. Data Jack Module – Cat 6 – 2 packages of 25

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Common work for communication systems shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2015 and ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling latest edition is hereby adopted to define such workmanship and the installation of communications horizontal cabling.

3.02 EXAMINATION

A. Examine products before installation. Reject products that are moisture damaged or physically damaged.

B. Examine elements and surfaces for compliance with installation tolerances and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 SYSTEM INSTALLATION

A. General Wiring Methods
1. Install horizontal cabling in raceways, inside walls, and above accessible ceilings.
2. In exposed areas, route cables in conduit.
3. Do not share conduits or sleeves with door security cabling or cabling of other low voltage trades. Coordinate with the electrical contractor for appropriate number of conduits and sleeves.
4. All cabling routed through walls or floors shall be installed in a conduit sleeve of appropriate size for cables installed.
    a. Conduit sleeve shall include plastic bushing on each end.
    b. Conduit sleeve shall be neatly installed and wall shall be patched if broken out on either side.
    c. In areas using existing penetrations not sleeved, provide split sleeve protection.
    d. Conduit sleeves shall not exceed 40% fill.

5. Cables shall not be supported on ceiling support systems, water, gas, or any other utility system.
6. Independently support horizontal cabling above accessible ceiling with j-hooks or cable tray (if present). Cables shall not be draped across the ceiling. Cable supports shall be mounted a minimum of 75 mm (3") above the ceiling grid supporting the false ceiling. Cable supports shall be provided by means that are structurally independent of the suspended ceiling, its framework, or supports.
7. All wire and cables shall be supported at least every 5 feet from the structure or as required to maintain no more than 12" cable sag between supports and without over tensioning the cables.
8. Provide raceway in areas where cables could be subject to physical damage (i.e. mechanical, storage,**]**, electrical rooms, etc.).
    a. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
9. All cables are to run at right angles to the structure, placed above ceiling in halls or corridors.
10. Cable terminations shall be in accordance with manufacturer's installation instructions and industry guidelines.
11. Device plates shall be vertically plumb with edges flush to wall and covering outlet box.
12. Wiring within Telecommunications Rooms:
    a. Bundle, lace, and train cables within cable tray / racks / D-rings.
    b. Cable bindings shall be by hook and loop (Velcro) and loosely fitted to prevent a change in the physical geometry of the cable. Use of nylon tie wraps is unacceptable. Comply with ANSI/TIA 568.0-D and BICSI Information Transport Installation Methods Manual (ITSIMM).
    c. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
    d. Provide and use wiring management.

B. Horizontal UTP or STP Cables
1. General Requirements for Cabling:
    a. Comply with current BICSI Information Transport Systems Installation Methods Manual (ITSIMM) "Cable Termination Practices."
    b. Install 110-style IDC termination hardware unless otherwise indicated.
    c. MUTOA shall not be used as a cross-connect point.
    d. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
        1) Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
        2) Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.
    e. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
    f. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools. Lacing bars shall restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
    g. Bundles shall not exceed 24 cables per bundle.
    h. Do not install bruised, kinked, scored, deformed, or abraded cable. Discard cable if damaged during installation and replace it with new cable.
    i. Service Loops:
        1) Length:
            (a) Information Outlets for Wireless Access Points (WAP): Provide 25-ft at the WAP end of cable.
            (b) All other Information Outlets:. Provide 1-ft at the workstation end of cable.
        2) Management:
            (a) Telecommunications Room shall be managed in the ladder rack. Bundles shall not exceed 24 cables per bundle.

j. Cabling shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
k. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
l. Do not exceed recommended pulling tensions. Comply with BICSI ITSIM, Ch. 4 "Pulling Cable." Monitor cable pull tensions.
m. Cables shall be coiled in in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. No more than 12" of slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack may be neatly coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
n. Use only hook and loop (Velcro) type tie wraps to dress cables. Wraps shall be installed snugly without deforming cable insulation. Ties shall be spaced at uneven intervals not to exceed 4-feet. No sharp burrs should remain where excess length of cable tie has been cut.
o. Maintain minimum bend radius of 4 times the outside diameter of the cable.
p. Do not untwist cables more than 1/2 inch from the point of termination to maintain cable geometry.
q. Remove no more than 1 inch of cable jacket.
r. Terminate horizontal copper cables per ANSI/TIA-568.0-D series standards as well as standard industry practice. Terminate T568B.

2. Open-Cable Installation:
   a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   b. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Installation of Cable Routed Exposed under Raised Floors:
   a. Install cabling after the flooring system has been installed in raised floor areas.
   b. Provide a 6-ft service coil below each feed point
4. Separation from EMI Sources:
   a. Comply with BICSI TDMM and ANSI/TIA-569 recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

C. Wireless Access Point System
1. Provide cabling for Wireless Access Point. Owner shall supply Wireless Access Point equipment for Contractor to install. Programming and setup shall be by Owner
2. Provide one Cat 6 cable to each wireless access point location. Provide a 25-ft service loop at the WAP end of cable. Terminate in a surface mount box (biscuit jack) and test per specifications for horizontal category cabling. Refer to plans and details for additional information.
3. Provide a green sticker and cable identification label on the ceiling grid directly below location of biscuit jack.

D. Patch Panels
1. Data patch equipment shall be installed in the rack positioned below any fiber shelf equipment supplied. Patch panels shall be spaced to allow data switches between each panel, allowing space for to install UPS on bottom half of rack. Fiber and copper patch panels shall not exceed 50% of the rack space. Horizontal manager shall be placed at the top, middle and bottom of each rack.

E. Conduit Pathway
1. No single bend shall be greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
2. No section shall exceed 100 ft. in length. Pull points or pull boxes shall be inserted so that no segment between points or boxes exceeds the 100 ft. limitation.
3. Bond to ground on one or both ends in accordance with national or local code requirements.
4. Shall not run over or adjacent to heat sources such as boilers, incinerators, hot water lines, or steam lines.

5. Each conduit shall have a pull string tied off at both ends.
6. All conduit ends shall be reamed and fitted with a suitable bushing.
7. Flex conduit shall not be used within walls, ceilings, or counters without prior approval.

3.04 DEMOLITION

A. Where demolition is indicated on drawings or project documents, Contractor shall be responsible for removal, collection, transportation, and disposal of all indicated cabling and components.
B. Removal shall consist of all components from end termination point to termination point of origin.
C. Contractor shall field-verify existing conditions prior to beginning demolition work. All discrepancies between existing conditions and specifications or drawings shall be reported to the Architect prior to the start of work in order to prevent disturbance of existing installations. Beginning work shall indicate acceptance of existing conditions. Contractor is responsible for immediately restoring any outages caused as a result of removing or damaging adjacent cabling, systems, or services.
D. Contractor shall provide and install blank cover-plates for any outlets that are to remain in place and from which all cables have been removed. Cover plates shall match the project standard color and finish.
E. If the Contractor removes anything from an opening in a fire-rated wall, the Contractor shall restore the fire-rating condition of the wall to the same condition as before the Contractor started the work. Depending on the size of opening, this may involve sheetrock patching, in addition to use of other appropriate fire-stopping materials.

3.05 PENETRATIONS OF STORM SHELTER ENVELOPE

A. Penetrations through the storm shelter envelope larger than 3 ½ square inches (2258 mm2) in area rectangular penetrations or 2 1/16 inches (52.38 mm) in diameter, shall be considered openings and shall be protected in accordance with Chapter 3, Section 306.3 of ICC 500.

3.06 FIRESTOPPING

A. Contractor shall be responsible for providing firestopping all wall and floor/ceiling penetrations and pass-throughs designated for technology use. Firestopping method shall meet or exceed the minimum rating of wall, ceiling or floor penetrated.
B. Comply with requirements in Division 07 Section "Penetration Firestopping."
C. Comply with ANSI/TIA-569-D, Annex A, "Firestopping."
D. Comply with BICSI TDMM, Chapter 7: Firestop Systems.

3.07 FIRESTOPPING

A. Contractor shall be responsible for firestopping all wall and floor/ceiling penetrations and pass-throughs designated for technology use. Firestopping method shall meet or exceed the minimum rating of wall, ceiling or floor penetrated.
B. Comply with ANSI/TIA-569-D, Annex A, "Firestopping."
C. Comply with BICSI TDMM, Chapter 7: Firestop Systems.
D. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, adds, and changes will occur.
E. Where non-mechanical products are utilized, provide products that upon curing do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
F. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
G. Openings for cable trays shall be sealed using re-enterable fire stopping pillows.

3.08 CAULKING

A. The Contractor shall be responsible for caulking wall and floor/ceiling penetrations that are not through fire rated barriers. The caulking shall provide acoustical separation by applying a sound barrier to the penetration.

3.09 GROUNDING AND BONDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors and Division 27 as indicated herein.
B. Comply with ANSI/TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

C. Ground all equipment per manufacturer's recommendations, BICSI TDMM and ANSI/TIA guidelines, NEC codes, and all other applicable code and regulations.

D. Bond all non-current carrying metallic equipment to the grounding bus bar. Equipment grounding conductor to be no smaller than No. 6 AWG.

3.10 IDENTIFICATION

A. Identify system components, wiring, and cabling by implementing labeling and color-coding standards per ANSI/TIA-606-B, Administration Standard for Telecommunications Infrastructure.

B. Cable Schedule: Install in a prominent location in each equipment room and Telecommunications Rooms. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications rooms, racks and cabinets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, telecommunication outlet assemblies and telecommunication outlet terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color. Utilize manufacturer designed labeling (Panduit laser/ink jet self-laminating labels or equal). Labeling method shall be permanent and minimally susceptible to vandalism.
2. Label both ends of cable runs within 6 inches of termination points.

E. Permanently label faceplates of information outlets with laser jet/ink jet self-laminating labels or equal. Labels shall be minimally susceptible to vandalism

F. Permanently label cross connect and patch panel terminations with identical numbers used at the outlets.

G. Label scheme shall follow ANSI/TIA-606-B as follows:

1. Telecommunications Room Number.Rack Number-Patchpanel Position:Port Number.
   a. Example: TR2.R1-4:08
   b. Indicates connection resides as follows:
      1) TR2 = Telecommunications Room 2
      2) R1 = Rack 1 in TR2
      3) 4 = Patch panel 4 (fourth patch panel in the rack, counting from top to bottom).
      4) 08 = Port 8 on Patch Panel 4 in Rack 1 of TR2
2. Contractor shall provide label scheme for Designer and owner to review and approve prior to labeling any patch panels or faceplates.

3.11 FIELD QUALITY CONTROL

A. Inspections:

1. Perform visual inspection of UTP materials for NRTL certification markings.
2. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with ANSI/TIA-568-C.2.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

B. Testing:

1. Testing shall be performed with equipment that has been calibrated in accordance with the manufacturer's specifications as well as factory calibrated within one year prior to being utilized to perform the tests herein.
2. Test UTP copper cabling for 100 percent of the pairs installed. Record the results of the test with cable identification and provide as part of the As-Built documents and cable management software. Any cable that fails shall be re-terminated and retested. If the cable fails the additional testing, the cable shall be replaced and retested.
3. Record test data records to the cable management software database. Database shall be loaded with structured cabling information for each drop, telecommunications room or enclosure, general path, and cross connects completed by Contractor for the entire physical layer installation.
4. Tests shall be performed after permanent labeling has been installed on cables, jacks, and panels.

5. Perform testing as described in ANSI/TIA-568.2-D Permanent Link Test and all published Annexes per the Category of cable installed.
6. Every cable shall be tested with a Level III tester or higher (e.g. Fluke DTS or DSX) with universal permanent link adapter for the following items, but not limited: correct polarity, continuity, opens, shorts, insertion loss, NEXT, PS NEXT, ACR-N, ACR-F, PS ACR-F, RL, length, propagation delay, delay skew, resistance, and wire map.
7. Test information along with manufacturer and model number of test equipment shall be included as part of the project As-Built documents. Submit final test reports after approval from the Engineer to the manufacturer of the certified cabling system for warranty of the system. Provide a copy of the material provided by the manufacturer indicating acceptance and warranty of the system. Provide originals to the Owner and train Owner on the procedures for receiving future warranty work.
8. Upon Owner or Technology Designer request for verification of documented findings, provide a random field re-test on 10% of the cable system at no additional cost. In the event that the random field re-test reveals contradictory information from the original test documents, re-testing shall be provided up to 100% of the cabling system provided as part of this project. Documentation included in the As-Built documents shall include all failed test results as well as the passed test results after corrections were made.

3.12 CLEANING

A. Upon completion of installation of communications backbone cabling, clear all blockages and remove burrs, paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.
B. Provide final cleaning, protection, and maintain conditions in a manner acceptable to manufacturer, which ensures system being free from damage and deterioration at time of Substantial Completion.

3.13 DEMONSTRATION

A. Perform a post-construction meeting and walk-through with Owner reviewing the final installation and covering the following items:
   1. Labeling Scheme
   2. Patching Requirements
   3. As-Built Document Layout

3.14 WARRANTY

A. The Contractor shall guarantee all materials and equipment for a minimum of one (1) year from date of substantial completion of this work. This guarantee shall include all labor, material, and travel time.
B. In addition, provide the longest available manufacturer's warranty, not to be less than 20 years. This shall be the Manufacturer's warranty covering a system installation of premium partner products.
C. Manufacturer's Warranty shall cover:
   1. Product defects.
   2. Components that do not meet or exceed the specifications of ANSI/TIA-568.0-D cabling links and channels.
D. Failure of the installed structured wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA-568.0-D component and link/channel specifications for cabling.
E. Contractor shall provide in the As-Built documents the numbered certificate from the manufacturing company showing registration of the installation.

END OF SECTION 27 15 00

SECTION 27 51 16
PUBLIC ADDRESS SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Introduction:
   1. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of a completely operational Public Address system as shown, required, and specified herein. The omission of express reference to any items or work necessary for, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor from providing such items or work.

B. Scope and Intent:

C. Renovation at the Nelson Care Center by Vivie. Project scope includes, but is not limited to, establishing new PA system in phases, demolition of existing PA system and associated cabling and speakers, Refer to specification sections and drawings for additional information. The system shall be an IP zoned paging system. Integration to other systems shall be as described within this document. Include management software and processing equipment, audio distribution equipment, cabling, and loudspeakers to accommodate a full functioning PA system for the entire Nelson Care Center facility.

D. The Public Address system shall have key functions as follows. Refer to entire specification section for additional information:
   1. The system shall interface with the building telephone system. Coordinate installation of SIP (teams) and IP telephone interface with the Owner or Owner's assigned representative for the required network lines or other interface and required programming.
   2. The system shall integrate with the Access Control System & Fire panel for the broadcast of custom pre-recorded emergency messaging and releasing fire door holds. Coordinate with the security / fire alarm contractor for the required interface, connections, and programming. Lock down and duress interface is also required.
   3. Voice paging to all loudspeakers, specific loudspeakers or specific speaker zones via telephone and PC workstations station.
   4. Emergency one-way voice paging to all interior and exterior speakers. Emergency paging shall override all local controls and sound systems.
   5. Distribution of custom pre-recorded messages upon activation from the building security systems via a programmable digital message repeater.
   6. The system shall integrate with any owner specified schedules.
   7. All zone cabling shall be neatly terminated within a wall mounted enclosure. All IP components will be install in the rack.
   8. Speaker types include but are not limited to:
      a. Ceiling mounted
   9. Master paging station located in the front office as well as each nursing station. Contractor will install and program software and Map style interface at each PC's to accommodate efficient easy paging.

E. Section Includes:
   1. Microprocessor based Public Address system
   2. Power amplifiers
   3. Digital Signal Processors
   4. Equipment cabinet
   5. Telephone paging adapters IP or SIP (teams)
   6. Digital message repeater
   7. Loudspeakers
   8. Input/Output panels
   9. Conductors and cables
   10. Raceways

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. 27 05 00 Common Work Results for Communications
2. 27 11 00 Communications Equip Room Fittings
3. 27 13 00 Communications Backbone Cabling
4. 27 15 00 Communications Horizontal Cabling
5. Division 26

1.03 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.04 REFERENCES

A. Standards:

1. EIA Compliance: Comply with the following Electronics Industries Association Standards:
   a. Sound Systems, EIA-160.
   b. Loudspeaker, Dynamic Magnetic Structures, and Impedance, EIA-299-A.
   c. Racks, Panels, and Associated Equipment, EIA-310-A.
   d. Speakers for Sound Equipment, SE-103.
   e. Microphones for Sound Equipment, SE-105.
2. NFPA 70, “National Electrical Code”
3. FCC Part 15- Unlicensed RF Devices
4. Audio Engineering Society (AES)
5. Institute of Electrical and Electronics engineers, Inc. (IEEE)
6. National Institute of Standards and Technology (NIST).
7. Underwriters Laboratories (UL) listed.

B. Codes:

1. Comply with the applicable building code, local ordinances and regulations, and regulations and requirements of the authority having jurisdiction.
2. Components and installation shall comply with NFPA 70, “National Electrical Code.”

1.05 INSPECTION OF SITE

A. Refer to section 27 05 00 Common Work Results for Communications for more information

B. Pre-Installation Meeting:

1. Arrange for pre-construction meetings to coordinate installation of public address intercom systems with Owner’s representative including but not limited to, Director of Facilities, Director of IT, and administrative staff. The Architect’s Technology Designer shall be included in these meetings.
2. Furnish attendees at the meetings with a diagram of the sound system installation.
3. Meeting shall include review of entire installation, including locations of equipment, layout of equipment in spaces, features, functions, capabilities, and integrations.
4. Review phasing of systems through the duration of the project.
5. Take attendance and minutes and submit with the close out documents.

C. Construction Meetings:

1. Attend construction meetings for coordination with other disciplines and trades.

1.06 COORDINATION

A. Electrical:

1. Conduct onsite meetings at each building to verify the exact location for each device rough-in that has been provided.
2. Verify proper power requirements have been provided for equipment installations.

B. Communications:
   1. Coordinate with network and other low voltage communications installers.
C. Owner:
   1. Coordinate with IT department to determine IP addresses and network port assignments where applicable.
   2. Coordinate with appropriate Owner personnel in the IT department and Facilities department to identify programming parameters.
   3. Coordinate with Architect to verify programming of custom pre-recorded messages follow egress plan and codes.
D. Other Trades:
   1. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.07 SITE CONDITIONS

A. The new public address system headend shall be located in the HR IT closet with each IP Amps located in the closest data closet to that zone . Coordinate pathway requirements with the other relevant trades.
B. Verify the mounting method and locations for loudspeakers

1.08 SUBMITTALS

A. General: Submit the following in accordance with the Conditions of the Contract and Division 1 Specification Sections.
B. Shop drawings and documents:
   1. Shop Drawings shall be submitted for approval for all components prior to commencing installation.
   2. Refer to specification section 01 for additional information on form and content of submittals.
   3. Provide a complete materials list, listing quantity, manufacturer, model number and description of the system components listed below
   4. Provide a manufacturer's specification sheet for all system components that comprise the public address system.
   5. Include plans, elevations, sections, details, and attachments for supports and seismic restraints for control consoles, equipment cabinets and racks, and components.
   6. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
   7. Console layouts.
   8. Control panels.
   9. Rack arrangements.
   10. Loudspeaker layouts to include loudspeaker locations and transformer wattage tap calculations.
   11. Power/Time calculations: For sizing backup battery.
   12. Wiring Diagrams: For power, signal, and control wiring.
      a. Identify terminals to facilitate installation, operation, and maintenance.
      b. Single-line diagram showing interconnection of components.
      c. Cabling diagram showing cable routing.
   13. Provide system block diagrams.
      a. Component layouts
   14. Provide samples of any or all proposed system components requested for examination/approval.
   15. Provide a sample of labeling scheme and method.
   16. Provide qualification documents as described in the quality assurance section. These are to include, but are not limited to:
      a. Manufacturer certification credentials of staff assigned to project for installation or equivalent certification
   17. Low voltage licensure credentials of staff assigned to project for installation.
   18. Programming Approvals: Submit electronic copy of the Programming Plans. These shall be reviewed with the Technology Designer and the Owner.

C. As-built drawings and documents:
   1. As-Built Documents shall be submitted for approval for all components listed below. Refer to specification section 01 for additional information on format and content of as-built submittals. Include the following documents:
      a. As-Built Drawings showing locations of all devices and cable routing on complete floor plans of 1/8" scale. Devices shall be indicated by their final label identifier. Handwritten data is not acceptable.
      b. Equipment layouts
      c. Labeling schemes and schedules
         1) Electronic copy of labeling schedules in software and format selected by Owner
         2) Electronic copy of labeling schedules that are part of the cabling an asset identification system of the software
      d. Equipment installation details
      e. Operation and Maintenance manuals
      f. Manufacturer's required maintenance related to system warranty requirements
      g. Test Results
      h. Record of Warranty
      i. Product Data: For each type of product indicated.
   2. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
      a. Qualification Data: For qualified Installer.
      b. Field quality-control reports.
      c. Operation and Maintenance Data: For public address system to include in emergency, operation, maintenance and warranty data manuals.

1.09 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Engage firms experienced and regularly engaged in manufacture of sound system, components and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
B. Product Qualifications:
   1. Provide materials listed by UL or ETL.
C. Installer Qualifications:
   1. Contractor shall meet the requirements listed below. Submit requested documents with shop drawings to verify compliance with contractor requirements.
   2. Minimum of 5 years of experience in the installation of the Bogen Nyquist 4000 or 7000 series product.
   3. Minimum of two installers that are Factory certified at the highest level offered by the manufacturer to program, install, and service the systems provided.
   4. Place of business that locally maintains the necessary spare parts in the proper proportion to this project, as recommended by the manufacturer, to maintain and service the equipment being supplied.
   5. Licensed in the state of Minnesota for all services provided.
   6. Shall be an authorized dealer.
   7. Provide upon request, the following information:
      a. Number of local technicians trained to provide installations meeting the product manufacturer's requirements.
      b. Length of time every technician has been employed in the PA/sound system and related installation business.
      c. Length of time every technician has been employed by the Company.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

B. Open each container, verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.

C. Test components upon receipt of Project site.

1.11 PROTECTION

A. Until final acceptance of work, Contractor shall protect all materials and equipment from damage.

1. Any components stored or installed on-site shall be protected with a minimum polyethylene or equivalent covering to protect from moisture, plaster, cement, paint, or other work of other trades.
2. If during shipment or installation, finish or equipment becomes chipped or scratched, Contractor shall touch up or refinish surfaces to match original finish, or replace if necessary.

B. Contractor is responsible to protect Owner's furnishings from damage due to their activities in occupied spaces and to clean up any debris created as a result of their work.

1.12 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

1.13 WARRANTY

A. Manufacturer's warranties that extend beyond the requirements of Division 01 shall be maintained and transferred to the Owner.

B. Maintain a sufficient parts inventory during the warranty period to meet the anticipated system repair times.

C. Prior to the expiration of warranty, system integrator shall provide all software patches available from software supplier. Upon completion of installation, test affected systems to confirm operation. Software patches shall be installed at time convenient to Owner

PART 2 PRODUCTS

2.01 GENERAL INFORMATION:

A. The products listed below establish the design intent and minimum installation requirements. Approved contractors are required to have expertise in the configuration and installation of these products. Contractor shall provide all product software, components, and cabling required for delivery of a complete and fully functional public address system. Use equipment complying with manufacturers' standard design and construction in accordance with published product information, and as required for complete installation.

B. All equipment and materials shall be new and bear a recognized testing laboratory's label, where applicable.

2.02 BUILDING PAGING SYSTEM

A. Manufacturers:

B. Manufacturers: Subject to compliance with requirements, provide products of the following:

a. Bogen - Nyquist C4000 solution:

1	NQ-C4000-B2	Nyquist C4000 Series System Software License - Bundle-2 (9 Zones / 10 CCLs / 3-Yrs S/W Updates)
1	NQ-C4000QPL	Nyquist C4000 Series System Software - Queued Paging / Page Stacking License (Per Queue)
1	NQ-C4000PBXI	PBX Integration Services
1	NQ-C4000TTS	C4000 System Software License - Text-To-Speech License (Per System)
1	NQ-C4000MBP	C4000 System Software License - Map Based Paging License (Per System)
1	NQ-C4000API	C4000 Series System Software - Routines Api (Per System)
1	NQ-C4SWUP3YRB2	3-Year Extended System Software Updates - Bundle-2 (Includes bug fixes & standard features in new releases)

1	NQ-SYSCTRL	Nyquist System Controller.
5	NQ-A2060-G2	Nyquist 2-Ch. X 60w 1u Audio Power Amp Gen2
5	NQ-RMK03	Nyquist 1U/2U Rack Mount Kit Type-3 (Single MMPA, SYSCTRL, A2xxx, or A4xxx)
1	NQ-RMK01	Nyquist 1U Rack Mount Kit Type-1 (MMPA-I/O Controller, SYSCTRL)
1	NQ-T1100	VoIP Admin Phone
1	NQ-E7010	Nyquist I/O Controller
See drawing	HFCS1LP	Reentrant Horn Loudspeakers
See drawing	CK10	10FT Safety wire
See drawing	TBCR	Tile Bridge Support Ring

C. System Performance Requirements
   1. Add to the existing system to provide a complete microprocessor based public address system.
   2. System shall be a fully distributed system allowing the Owner to address the entire building.
   3. The system shall have ability to announce pre-recorded messages upon notification from security systems.
   4. In the event of a power failure, the system shall switch over to the building backup UPS and maintain full functionality at all locations.
   5. Selectively control sound from system software or telephone system.
   6. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
   7. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
   8. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.
   9. Administrative capabilities shall be customizable to three levels, based on user access credentials.
   10. Corridor speakers, and outside horns shall be on separate circuits. A maximum of (12) speakers shall be connected on (1) circuit. Each corridor shall be a separate circuit. Outdoor speakers shall be on separate circuit(s).
   11. Provide zone capabilities for corridors, exterior, wings, and all call. See drawing for additional information.
   12. System must support a visual console software application that allows for the operation of the Paging System from multiple Windows based PC. This software package shall utilize an easy-to-use graphical user interface (GUI), allow routine call processing from nurses stations, quick graphical access to paging, and program distribution. Software application shall also allow easy activation of schedules. Emergency operations shall be simplified through this software application by allowing stored audio files, alphanumeric message displays to be activated from the GUI. GUI shall allow common operations such as daily announcements to become automated with the use of the visual console, removing multi-step console set ups. While all operations are conducted from the PC screen, the administrative console or telephone handset shall provide the means for originating voice communications to selected locations.
   13. System must provide interface to the telephone system. Interface shall allow the following minimum features, including but not limited to.
       a. Paging into each speaker circuit or zone
       b. Automatic message activation
       c. Activation of tones.

14. Software must allow the creation of a custom operating screen based on the floor plans of the facility. Icons representing and paging, monitoring, and audio program zones shall be incorporated onto the floor plans.
15. Software GUI shall provide:
    a. Simple Routine Call Processing
    b. Emergency Functions
    c. Paging
    d. Program Distribution
    e. Enabling and Disabling of Schedules
    f. Customizable Page Elements
    g. Customizable Operating Screen
    h. Element Library for Emergency Event Icons
16. Visual console must provide an efficient and reliable method of notifying the occupants of a facility of critical situations. A variety of emergency tone signals that reside within the Paging System shall be activated by clicking on pre-programmed buttons on the PC GUI screen, initiating the transmission of tone signals to speakers and/or alphanumeric messages to electronic message displays
17. It shall be complete with circuitry for accomplishing all functions for signaling and communications to all stations, page zones, and administrative control consoles. Unit shall contain all required electronics on modular, plug-in type boards for ease of service, and future expansion.
18. All programmable functions shall be stored in a non-volatile EEPROM memory and shall not be lost in event of a power failure.
19. Programming functions shall be accomplished through the use of a standard Internet web-browser interface. Any PC connected to the facilities network and provided with the proper authorization shall have multi-level access to system programming. Any off-site PC shall have multi-level access to the system through the use of the public internet, provided they have been granted proper authorization.
20. Paging system shall be connected to a care center provided Ethernet network port using the TCP/IP protocol for PC programming, performing diagnostics, or logging transactions either on or off-site.
21. System shall support remote programming and support through a wide area network connection.
22. Programming interface shall support configurations for multiple sites and allow the user, after logon, to select which site to program from a list of all sites.
23. User interface shall support usernames and passwords using Active Directory. There shall be multiple levels of access allowed. User level of authorization shall be determined by the Owner and programmed by the Contractor.
24. Program shall also serve as part of the documentation process. Page zones and schedules shall support user-definable names and display as pick lists when editing the configuration.
25. Diagnostic functions shall be accomplished through any PC connected to the Nelson Care Center network and provided with the proper authorization and diagnostic software. Any off-site PC shall have access to the system for diagnostics through the use of the public internet, provided that they have been granted proper authorization and have been provided diagnostic software.
26. Although the PA system is programmed through a PC interface, the system shall not have to rely upon a personal computer for day-to-day operation. All programming information is loaded into the paging system allowing independent operation of the system.
27. The final copy of the program and the configuration of data files shall be provided to the Nelson Care Center in electronic format.
28. Audio channel(s) shall be priority driven allowing for the highest priority signal type access to a voice channel. System shall be user programmable to allocate, upon demand, either of the channel(s) to facilitate simultaneous pages, program distributions, or combination thereof.
29. Work with owner to identify if any pre-announce tones will alert of incoming calls with distinct tones for each priority level.
30. Provide automatic gain control on paging speech to ensure constant speech level.
31. System will provide emergencies and All Call paging

32. Distribution of paging announcements can be made from any administrative control console, telephone.
33. Emergency announcements shall have the highest priority over any other system function.
34. System shall support general announcements made from a conventional microphone to facilitate reading a script and the participation of multiple announcers.
35. Announcements shall automatically mute all other audio programs at a lower priority in the system and transmit the audio to all rooms or specific speaker zones, as programmed into the system software.
36. System must have the capability of distributing audio program sources from any administrative control console, telephone system phone. Program distribution shall be accomplished on an all-rooms basis, selected rooms basis or an individual room.
37. Inputs shall be provided from at least 3 different line level sources and 5 different low impedance sources. Available inputs include microphones, tuners, tape players, or auxiliary sources.
38. Program source(s) can be located remotely from the central electronics so that the customer does not have to go to the communications closet to select the program.
39. Control console shall be able to selectively monitor program sources being distributed.
40. Central control unit shall provide a 0 dB signal for connections to an external amplifier for distribution of program audio, time signals, and paging announcements.
41. System shall provide capability for multiple open voice paths used for paging, program distribution, or emergency paging (minimum of 2). These paths shall be global, non-blocking circuitry. Systems offering multiple-speech paths, which are restricted to a single speech path per group of room stations or circuit card, due to hardware constraints, will not be accepted.
    a. Ability to produce different tone signals for emergency signals selected from a combination of over 1,500 tones. System shall be programmed for tones, such as but not limited to:
        1) Pre-Announce Tone
        2) Severe weather and other pre-recorded announcements
    b. Duration of the tone, as well as frequency, burst length and output level shall be software programmable from the console or a web browser.
    c. System shall support running all time schedules concurrently.
        1) Durations in seconds: 2, 3.5, 5, 6, 8, 10, or 12
        2) Frequency
        3) Duration
        4) Level
        5) Burst
42. System shall provide the ability to have music on allowing any source to be distributed to specific program zones.
43. Transformer tap on each speaker shall be specifically adjusted to operate at a minimum of 10 decibels above normal ambient sound level in the space.
44. In the event of a power failure, the system shall switch over to UPS power and maintain full functionality at all locations.
45. Administrative capabilities shall be customizable to a minimum of three levels, based on user access credentials.
46. Shall be 19” rack mountable.

D. Audio media player
1. Provide an audio player for music that can be played through the paging system during programmed times that the owner would like.
2. 19” rack provided as part of 27 11 00
3. AM/FM tuner
4. Support removeable USB thumb and HDDs, SD/SDHC cards
5. Plays CD, MP3, WAV and ACC files

6. Bluetooth capable
7. 3.5” stereo audio input jack.
8. Unbalanced combi audio output
9. Approved manufacture: Denon DN-300Z

E. Equipment Cabinet
1. Provide wall mounted equipment cabinet appropriately sized to house consolidated speaker wiring and terminal strips. All IP related equipment shall be 19” rack mounted. Rack provided as part of 27 11 00.
2. Comply with TIA/EIA-310-D.
3. The equipment cabinet will be permanently mounted AFF.

F. Digital Message Repeater
1. Digital message repeater shall provide pre-recorded emergency messages to the public address system.

G. Amplifiers
1. Power amplifiers shall be sized for a load calculation based on 1 watt per speaker, 2 watts per corridor speaker. Amplifier load shall not exceed 75 percent capacity. Provide quantity of amplifiers as required for each zone.
2. Amplifiers shall be capable of producing an audio output of 60-, 125-, or 250-watts RMS at less than 1 percent distortion with a balanced output.
3. They shall be designed to operate on a line voltage of 70volts. One amplifier shall be provided for each audio channel/zone.

H. Ceiling mounted speakers
1. High fidelity speakers:
   a. Surface-Ceiling-Wall-Mounting Units:
   b. Minimum Axial Sensitivity: 89 dB at one meter, with 1-W input.
   c. Frequency Response: Within plus or minus -10 dB from 78 to 19,000 Hz.
   d. Matching Transformer: Full power rated with four taps. Maximum insertion loss of 0.5 dB.
   e. Tap for 70 volts.
   f. Surface-Mounting Units:
      1) Ceiling as indicated
      2) In steel back boxes, acoustically dampened.
      3) Recessed volume control, accessible from front of speaker
      4) Size: 12-5/16” dia inches with low profile depth 6-34”.
      5) Approved manufacturers:
         (a) Bogen
         (b) Part #: HFCS1LP
      6) Provide tile bridge support rings and cable kits.

I. Conductors and Cables
1. Plenum Cable: Listed and labeled for plenum installation.
2. Jacketed, twisted pair and twisted multipair, untinned solid copper.
3. All cabling for the Paging system shall be Yellow in color. 18/2 shielded minimum.

J. Raceways
1. Coordinate with the Electrical Contractor.
2. Conduit and Boxes:Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
   a. Outlet boxes shall be not less than 2 inches (50.8 mm) wide, 3 inches (76.2 mm) high, and 2-1/2 inches (64 mm) deep.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION:

A. Common work for communication systems shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 and ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling latest edition is hereby adopted to define such workmanship and the installation of communications cabling.

3.02 EXAMINATION:

A. Examine areas and conditions under which public address system components are to be installed for compliance with requirements and other conditions affecting the performance of the public address systems work.

B. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify actual locations of conduit and back boxes before device installation.

C. Examine ceiling spaces to assure proper clearance for loudspeaker components. Check for HVAC ductwork, piping, cable trays, and other obstacles that may interfere with loudspeaker backbox installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION:

A. Prepare project planning documents for review and approval.
   1. Complete system diagnostics and operation verification.
   2. Prepare a specific plan for system testing, startup, and demonstration.
   3. Develop acceptance test concept and, on approval, develop specifics of the test.
   4. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

B. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system parameters,

3.04 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.05 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.06 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:
   1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
   2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
   3. Secure and support cables at intervals not exceeding 30 inches (762 mm) and not more than 6 inches (152.4 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (203.2 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
4. PA Cabling shall not be combined with other system cabling.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (304.8 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
1. Cabling shall not be combined with other system cabling.

3.07 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Equipment Cabinets and Racks:
1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

D. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

E. Wall-Mounted Outlets: Flush mounted.

F. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

G. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG shielded.

H. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

I. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

K. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

L. Cables shall be independently supported by cable supports/loops.
   1. All wire and cables shall be supported at least every 4-5 feet (152.4 cm) from the structure or as required to maintain no more than 12” sag between supports and without over-tensioning the cables.

M. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.08 PROGRAMMING

A. Provide necessary programming.

3.09 FIRESTOPPING

A. Contractor shall be responsible for firestopping all wall and floor/ceiling penetrations and pass-throughs designated for technology use. Firestopping method shall meet or exceed the minimum rating of wall, ceiling or floor penetrated.

B. Comply with requirements in Division 07 Section "Penetration Firestopping."

C. Comply with ANSI/TIA-569-D, Annex A, "Firestopping."

D. Comply with BICSI TDMM, Chapter 7: Firestop Systems.

3.10 CAULKING

A. The Contractor shall be responsible for caulking wall and floor/ceiling penetrations that are not through fire rated barriers. The caulking shall provide acoustical separation by applying a sound barrier to the penetration.

3.11 GROUNDING AND BONDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors and Division 27 as indicated herein.

B. Comply with ANSI/TIA-607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

C. Ground all equipment per manufacturer’s recommendations, BICSI TDMM and ANSI/TIA guidelines, NEC codes, and all other applicable code and regulations.

D. Bond all non-current carrying metallic equipment to the grounding bus bar. Equipment grounding conductor to be no smaller than No. 6 AWG.

E. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

F. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Ground per NEC and as recommended by manufacturer’s written instructions.

G. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

H. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding

3.12 IDENTIFICATION

A. Develop Cable Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with same designation. Use logical and systematic designations for facility's architectural arrangement. Where category 6 cables are used for IP devices, follow Owner’s standard for labeling. Adhere to ANSI/TIA-606-B standards.

B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

C. Labeling method shall be approved by the Owner and the Technology Designer before implementing.

3.13 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:
   1. Schedule tests with at least seven days' advance notice of test performance.

C. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.

D. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

E. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

F. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers

H. Public address system will be considered defective if they do not pass tests and inspections.

I. Prepare test and inspection reports.
   1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.14 TESTING

A. All system functions shall be tested for proper performance. All test results shall be documented for inclusion in the As-Built Documents.

B. Contractor shall provide complete system programming and control software in coordination with the Owner and Architect. The programming shall be done by a person that has received factory training in the programming of the installed system. Any programming not coordinated with the Owner that does not meet the Owner’s wishes, shall be corrected a no charge to the Owner.

C. Prepare test and inspection reports.
   1. Contractor shall perform final acceptance testing in the presence of Architect’s representative and Owner’s representative, executing a point by point inspection against a documented test plan that demonstrates compliance with system requirements as designed and specified.
   2. Acceptance by Architect’s representative or Owner’s representative is contingent upon successful completion of check-off; if check-off is not completed due to additional work required, re-schedule and perform complete check-off until complete in one pass, unless portions of system can be verified as not adversely affected by additional work.
   3. System shall not be considered accepted until all acceptance test items have been successfully checked off. Beneficial use of part or all of the system shall not be considered as acceptance.
   4. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
   5. Provide report indicating every speaker was tested, audible, and intelligible. Items indicated on this sheet shall include but not be limited to:
      a. Room number
      b. Speaker was set to provide a sound level of 10dB above the ambient sound level of the space in which it is installed
      c. Speaker is audible
      d. Speaker is intelligible
      e. Emergency notifications audible with volume set to 0
      f. Date of test
      g. Initials of contractor performing test

D. Adjusting
   1. Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.
   2. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.15 CLEANING

A. Upon completion of installation, clear all construction related debris and blockages, and remove paint splatters and other spots, dirt, and dust. Touch up scratches and mars of finish to match original finish.
B. Provide final cleaning, protection, and maintain conditions in a manner acceptable to the Technology Designer, the Owner, and the manufacturer, which ensures system being free from damage and deterioration at time of Substantial Completion.

3.16 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address systems and equipment.
B. Engage the services of a factory authorized service representative to provide integration services and to demonstrate and train Owner’s maintenance personnel.
C. Training shall be in person. Webinars are not acceptable.
D. Owner shall designate personnel to be trained.
E. Provide on-site, in-service training in the operation of the system. The training may be divided into separate sessions as required by the Owner in 2-hour increments. This includes multiple trips to the site as required.
F. Provide hands-on training with operational equipment.
G. Provide printed training materials for each trainee. Instructional materials and content shall be customized for and relevant to this particular installation.
H. Training shall be oriented to the specific system being installed under this Contract as designed and specified.
I. Contractor shall have a sign-up sheet for each training session to keep a record of attendees, time, and date. Contractor shall provide a copy of this sign-up sheet to the Owner.
J. All training shall be coordinated through the Owner’s Representative to ensure that all necessary personnel are in attendance at each training session.
K. Schedule training with at least 7 days of advance notice.
L. Develop separate training modules and provide printed training materials for each trainee for the following
   1. Owner’s Operating Personnel:
      a. Train in the programming and operation of the new system installed or addition. Train Owner’s maintenance personnel in the procedures and schedules involved in programming, operating, troubleshooting, servicing, and preventative maintenance of the system.
      b. Provide a minimum of 2 hours for the Building Paging System
      c. Provide contact information for technical support personnel.

3.17 WARRANTY:

A. The contractor shall guarantee the system including all components, parts, and assemblies, in its entirety to be free from mechanical and electrical defects for a period of at least three years (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.
B. The contractor shall provide three years of software maintenance and upgrades.

END OF SECTION 27 51 16

SECTION 27 52 23.01
NURSE CALL-CODE BLUE AND WANDERGUARD SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. The owner will provide a nurse call system with electrical contractor rough-ins. The electrical contractor shall provide all power, empty boxes and conduit for the nurse call system. The electrical contractor shall also include cabling required for proper interfacing of the nurse call system with the door access system, fire alarm system, and door hardware devices. The nurse call equipment, wiring and devices shall be provided by the Owner.

B. The electrical contractor shall provide a wanderguard system.

1.02 SUBMITTALS

A. Nurse Call

1. Provide owner furnished, owner provided nurse call drawings and cutsheets for reference. Obtain from Owner's Vendor.

B. Wanderguard

1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
    a. Detail equipment cabinets and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    b. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
    c. Station Installation Details: For built-in equipment, dimensioned and to scale.
3. Field quality-control reports.
4. Warranty.
5. Closeouts – Operation and maintenance documents.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.

C. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. The System Supplier shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least five years. The System Supplier shall hold all applicable state and local licenses.

1. The System Supplier shall be an Authorized Distributor for the product proposed with full manufacturer's warranty privileges.
2. The System Supplier shall employ technicians who have attended and successfully completed the manufacturer's technical certification classes for the proposed system.
3. The System Supplier shall show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system on a 24-hour / 7-day basis. The System Supplier shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

1.04 WARRANTY

A. The System Supplier shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of one year from the date of acceptance.

B. In addition, the equipment (parts) warranty for all core system components including control / switching equipment, power supplies, patient stations, sub-stations, and nurse consoles shall extend to a total of at least five (5) years. Warranty for ancillary devices such as pillow speakers and call cords shall extend to a total of at least two (2) years.

C. Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the warranty period for any product feature enhancements.
D. After the acceptance of the system(s) service shall be provided on the following basis:
    1. Emergency Service -Provided 24 hours a day. When a total or catastrophic failure of equipment is reported to contractor, within 2 hours of notification, a service person will be on site. (An example of a catastrophic failure would be a hub failure or a nurse console failure.)
    2. Routine Service - Provided within 4 business hours (9 a.m. to 5 p.m., Monday through Friday, excluding holidays) of notification. When a minor failure or equipment is reported to contractor, a service person will be on site within 24 hours of notification. (An example of a minor failure includes peripheral equipment such as control stations, entertainment speakers, corridor lights, pull-cord stations, etc. which normally affect only one patient or patient room.)

1.05 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
    1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nurse Call Manufacturers: Owner to provide PalCare wireless system.
B. Wanderguard Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Accutech 2400
    2. Code Alert
    3. Stanley
    4. Or Approved Equal
C. Coordinate the features of materials and equipment to form an integrated system. Match components and
D. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities adequate to increase the number of stations in the future by 25 percent above those indicated without adding internal or external components or main trunk cable conductors.
E. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.
F. Equipment: Solid state, modular.
G. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.

2.02 FUNCTIONAL PERFORMANCE

A. Nurse Call
    1. Patient Station Call: Lights a steady call-placed lamp on the station, location identification in the scrolling display signs and steady lamps at the central annunciator and other system display devices and displays message on master and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the respective annunciator and master and staff/duty stations. The central annunciator and master station identify the calling station.
    2. Pull-Cord-Call Station Call: Flashes a call-placed lamp on the station and distinctive-color lamps location identification in the scrolling display signs and steady lamps at the central annunciator and other system display devices and displays message on master station and pagers.
    3. Pocket Pagers: Associated pocket pagers will go into alarm when calls are initiated.

4. Wireless Repeater: receives and decodes signals from transmitters and then re-transmits them to the receiver.
5. System Reset: Operating reset button at the originating station cancels signals associated with the call. Illuminates a green digital display on the patient station and log presence on the master station.
6. Provide connection to fire alarm system at doors with magnetic locks.

B. Wanderguard:
1. Residents shall wear RFID tags in either bracelet or pendant form. When a tag approaches a door equipped with Wanderguard sensors, the associated magnetic lock will arm and lock the door and generate a local audible alarm and send an alarm to the Wanderguard system. Alarm can be disarmed from keypad located at the door. When door contacts are present, the security system shall also receive a door alarm signal.

2.03 NURSE-CALL SYSTEM

A. Call Station:
1. Provide box and conduit to accessible ceiling space.

B. Scrolling Display Signs:
1. Provide 120V receptacle with critical power.

C. Wireless Repeater:
1. Provide 120V receptacle with critical power.

D. PC Client Station:
1. Provide 120V receptacle with critical power and data outlet.

E. Low Voltage Cable: By Owner's vendor.

F. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

G. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

H. Grounding Components: Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems."

2.04 WANDERGUARD SYSTEM

A. RFID Tag
1. Radio frequency identification tag that contains a unique number or identifier. Small, lightweight, waterproof, hypoallergenic and easy to clean. Supplied with wristband or pendant to be worn around neck.

B. Door Controller/Receiver
1. Generates a coverage field for the monitored door or double door. Controls an antenna which emits a continuous signal. Can be integrated with access control system. Local audible annunciation when door is in alarm. Dry contact outputs for connection to fire alarm and other systems.

C. Magnetic Lock
1. NFPA 101 compliant. Controlled by the door controller and normally be de-energized. This will allow free egress through a monitored door for staff, visitor or residents without a RFID tag. If a tag enters the monitored door, the lock will energize. If pressure is applied to the door while locked for more than a designated time, the door will release. Lock shall release during fire alarm or when initiated by external signals.

D. Door Contact
1. Monitors if doors are ajar and sends alarm to system. Connect to door controller/receiver.

E. Keypad
1. Shall allow reset of the local alarm and de-energizes the magnetic lock.
2. 12 button with up to 100 different (4 to 8 digit) user codes.
3. Three LED indicators: When unit is in alarm. To indicate power available. And to indicate output relay is active.
4. 1-gang box mounting.

F. Override Button
   1. Button shall temporary de-energize the magnetic lock to allow travel from unsecured side to secured side.
   2. Three LED indicators: When unit is in alarm. To indicate power available. And to indicate output relay is active.
   3. 1-gang box mounting.

G. Power
   1. Provide duplex receptacle in pleum rated enclosure above ceiling. Receptacle to provide power for system. Provide wiring to each component.

H. Software
   1. Different levels of password access to ensure security.
   2. Records all activities including alarms (door alarm, loiter, door ajar, supervisory, low battery, etc). Variety of reports can be generated and printed.
   3. Be capable of identifying resident and location of door that is in alarm.

2.05 CONDUCTORS AND CABLES

A. Data Cable and Hardware: Category 5 UTP and UTP hardware. Comply with requirements in Section 271500 "Communications Horizontal Cabling."

B. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

2.06 WALL PLATES AND FINISHES

A. Station Faceplates: High-impact plastic, beige color. Molded or machine-engraved labeling identifies indicator lamps and controls.

PART 3 EXECUTION

3.01 INSTALLATION

A. Wiring Method:
   1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used.
      a. Install plenum cable in environmental air spaces, including plenum ceilings.
      b. Conceal raceway and cables except in unfinished spaces.
   2. Cable Trays: Comply with requirements in Section 271500 "Communications Horizontal Cabling."
   3. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
      a. Outlet boxes shall be no smaller than 4 in square.

B. It shall be the responsibility of the facility to provide a dedicated 120 VAC, 60 HZ conduit feed into the equipment cabinet. This power feed shall not have any other devices connected directly to it. A 20 AMP circuit breaker located in the electrical sub-panel labeled "nurse call" will control this circuit. This electrical circuit will be connected to the facility's emergency power system for automatic power switch over during loss of utility power.

C. Connect all network system power supplies and equipment cabinets to a common earth ground utilizing a 14 AWG, or larger, solid conductor which is at minimum the same conductor size as the AC feed wires.

D. Contractor shall protect network devices during unpacking and installation by wearing manufacturer approved ESD wrist straps tied to chassis ground. The wrist strap shall meet OSHA requirements for prevention of electrical shock, should technician come in contact with high voltage.

E. Install cables without damaging conductors, shield, or jacket.

F. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.

G. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
   1. Pull cables simultaneously if more than one is being installed in same raceway.
   2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
   3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.

H. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, or fittings.

I. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

J. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide 12-inch (300-mm) minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.

K. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.

L. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.

M. Identification of Conductors and Cables: Comply with requirements in Section 271500 "Communications Horizontal Cabling" for cable administration, cable schedule, and cable and wire identification.

N. Equipment Identification:
   1. Comply with requirements in Section 260553 "Identification for Electrical Systems" for equipment labels and signs and labeling installation requirements.
   2. Label all cabinets using approved consistent nomenclature. Stations shall not be required to be labeled.

O. Electrical Connections:
   1. Provide 120V critical emergency power to Wanderguard door controllers.
   2. Provide 120V critical emergency power to nurse call cabinets. Coordinate exact locations with Owner’s vendor.

3.02 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.

C. Grounding Provisions: Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Schedule tests a minimum of seven days in advance.
   2. Report: Submit a written record of test results.
   3. Operational Test: Perform an operational system test and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and "All Call" messages and pages at each nurse-call station. Verify proper routing, volume levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:
      a. Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 mPa of sound pressure.

b. Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
c. Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.

4. Test Procedure:
a. Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
b. Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings using the following procedure: Disconnect a speaker/microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.
c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse-call equipment amplifier, and measure the distortion in the amplifier output.

C. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

E. Prepare test and inspection reports.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal operating hours for this purpose.

3.05 DEMONSTRATION

A. Provide (8) hours to engage a factory-authorized service representative to train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.

END OF SECTION 27 52 23.01

SECTION 28 31 11.01
FIRE ALARM SYSTEMS (REMODEL OR ADDITION)

PART 1 GENERAL

1.01 SCOPE

A. This Section includes the furnishing and installation of all labor, materials, tools, appliances, hardware, junction boxes, and ancillary equipment for and incidental to the delivery, installation, and furnishing of an alteration / addition / extension to the existing complete and workable digital, addressable Notifier Onyx NSF2 3030 fire alarm system as shown, required, and specified herein. All devices, appliances, components added shall be compatible with the existing system. Fire alarm system design shall be approved by the authorities having jurisdiction.

B. Provide complete addressable fire alarm system, including but not limited to:
   1. Manual fire-alarm boxes.
   2. System smoke detectors.
   3. Carbon monoxide detectors.
   4. Multicriteria detectors.
   5. Heat detectors.
   6. Notification appliances.
   7. Magnetic door holders.
   8. Remote annunciator.
   9. Addressable interface devices.

1.02 DEFINITIONS

A. NICET: National Institute for Certification in Engineering Technologies.

1.03 SUBMITTALS

A. General Submittal Requirements:
   1. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire-alarm system design.
      b. NICET-certified fire-alarm technician, Level III minimum.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For new or altered components of fire-alarm system include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, control panel arrangements, and location and size of each field connection.
   2. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
   3. Device Address List: Coordinate with final system programming.
   4. Sensor / detector detection patterns and adjustment ranges.
   5. Include voltage drop calculations for new notification appliance circuits, and existing circuits that are expanded.
   6. Include battery-size calculations.
   7. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   8. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
   9. Include signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
   10. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

11. Wiring Diagrams: While “typical” connections and circuits are of interest, a complete system Shop Drawing shall be prepared for this particular project which includes device layout, point-to-point wiring diagram(s), and conductor sizes and types. For power, signal, and control wiring.
    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

D. Samples of any or all proposed system components shall be submitted for examination/approval as requested.

E. Qualification Data: For qualified installer. Provide NICET III and manufacturer certification credentials of staff assigned to project. Provide low voltage licensure credentials.

F. Upon completion of the shop drawings, submit to the reviewing agencies for approval. The reviewing authorities may include the following:
    1. State Fire Marshal
    2. City/Local Fire Marshal
    3. Health and Building Department

G. Submit copies of the shop drawing submittal to the Engineer. Copies submitted shall be stamped “approved” by each of the reviewing agencies. “Approved” copies submitted shall include copies of the agencies reviewer comments.

1.04 CLOSEOUT SUBMITTALS

A. Field quality-control reports.

B. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, maintenance and warranty data manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
    1. Record, ‘As-built’, drawings.
    2. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
    3. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
        a. Provide test results of notification devices in area of remodel and of area adjacent to remodel.
        b. Provide test results of initiation devices with verification of proper system response to added device initiation. Provide / verify address(es) of added devices are unique and existing devices and functionality have not been altered.
    4. Record copy of site-specific software.
    5. Device address list.
    6. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
        a. Frequency of testing of installed components.
        b. Frequency of inspection of installed components.
        c. Requirements and recommendations related to results of maintenance.
        d. Manufacturer's user training manuals.
    7. Manufacturer's required maintenance related to system warranty requirements.
    8. Abbreviated operating instructions for mounting at fire-alarm control unit.

C. Fire Alarm Placard: Submit placard as described in Part 2.

1.05 QUALITY ASSURANCE.

A. The products provided by this section shall comply with the following applicable references (latest edition):
    1. NFPA 72 – Fire Alarm Code
    2. NICET: National Institute for Certification in Engineering Technologies.
    3. UL 864 – Standard for Control Units and Accessories for Fire Alarm Systems

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project. Installer shall have a minimum of five years documented experience. Supervision of installers shall be by personnel certified by NICET as fire-alarm Level III minimum technician.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company or in the form of a placard by an FMG-approved alarm company.
E. The equipment manufacturer shall be regularly engaged in manufacture of fire alarm systems, of the types and capacities required, and whose products have been in satisfactory use in similar service for not less than ten years.
F. Source Limitations: Obtain fire alarm system from single source from single manufacturer.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
   1. Notify Owner no fewer than one week in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
B. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
C. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.07 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.
B. Upgrade Service: Update software to latest version at Project completion.

1.08 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.09 EXTRA MATERIALS

A. Provide (furnish and install complete) extra materials, devices, wiring/connections, programming, etc., at locations to be determined during construction. See detail on drawings for quantities. If not installed, the devices shall be turned over to the Owner (packaged with protective covering for storage and identified with labels describing contents) for extra materials at completion of the project.

PART 2 PRODUCTS

2.01 GENERAL INFORMATION.

A. All electrical equipment and material shall be new and bear a recognized testing laboratory’s label, where applicable. The type of equipment and/or material shall be designated by the location where it will be installed and so defined by NEMA / NFPA 70 standards.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, all devices, appliances, components, etc. added shall be compatible with the existing system.

2.03 SYSTEMS OPERATIONAL DESCRIPTION

A. All added / altered devices, appliances, components, etc. shall operate in the same manner as similar devices, appliances, components, etc. within the existing system. Typical functions are listed below. Field verify existing system functionality.
B. Fire-alarm signal initiation shall be by one or more of the following devices:
   1. Manual stations.
   2. Heat detectors.

3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Fire-extinguishing system operation.
8. Fire standpipe system.

C. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciator.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Recall elevators to primary or alternate recall floors.
9. Activate emergency shutoffs for gas and fuel supplies.
10. Record events in the system memory.

D. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.

E. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

F. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciator.

G. Door Controls:
1. Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
2. In addition to requirements above, release door hold opens upon activation of access control duress button. Provide relay and coordinate with access control installer as required.

H. HVAC Unit Shutdown:
1. Provide local actuation type smoke duct detector within the return ductwork of every mechanical unit exceeding 2,000 CFM.
2. Upon alarm condition, the fire alarm system shall de-energize all HVAC units that exceed 2000 CFM.

I. Sprinkler System Motorized Valve:
1. Provide control module with relay for signal wiring.
2. Fire alarm system shall be programmed for relay to be initiated by the desired fire alarm monitoring points (flow switches typically).
3. Fire alarm relay shall open/close valve.
4. Valve shall be powered open from a 120VAC emergency power circuit (where available) to avoid nuisance closures when the power goes out.

J. Kitchen Hood Control:
   1. The kitchen is equipped with a fire suppression system that shall be monitored by the fire alarm control panel.
   2. Upon release of fire suppression the fire alarm system shall receive a signal and shunt-trip the power off for all electrical devices under the hood.
      a. Provide all control relays, wiring, etc. required for de-energization of the electrical devices.
      b. Light fixture under hood shall be shunt trip when fire alarm system is in alarm condition. Feed light from separate shunt trip breaker.
   3. Upon alarm release the gas solenoid valve serving equipment shall close. Provide all control relays and wiring to shut solenoid valve. The solenoid valve shall be reset manually via reset button on valve assembly.

2.04 FIRE-ALARM CONTROL UNIT

A. Verify existing fire alarm control panel capacity. Provide cards / batteries / power supplies / terminal strips / ancillary equipment in the existing fire alarm control panel as required to supply added devices, appliances, components, etc.

B. Circuits:
   1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
      a. Signaling Line Circuits: Style 6
      b. Maintain 25% spare capacity on each addressable loop.

2.05 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   2. Station Reset: Key- or wrench-operated switch.
   3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.06 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
   3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

B. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).
   3. Weatherproof Duct Housing Enclosure: UL Listed to standard 268A.
   4. Each sensor shall have multiple levels of detection sensitivity.
   5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
   6. Relay Fan Shutdown: In addition to signaling the fire alarm control panel, the duct smoke detector shall shut the unit down on activation of the duct smoke detector Provide interface module as required. Rated to interrupt fan motor-control circuit.

2.07 SYSTEM CARBON MONOXIDE DETECTORS

A. General Requirements for System Carbon Monoxide Detectors:
   1. Comply with UL 2075.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
   3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring. Locate, mount, and wire according to manufacturer's written instructions.
   4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
   6. Test button simulates an alarm condition. Testable by introducing test carbon monoxide into the sensing cell.

2.08 MULTICRITERIA DETECTORS

A. Mounting: Twist-lock base interchangeable with smoke-detector bases.
B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
C. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.
D. Test button tests all sensors in the detector.
E. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   1. Primary status.
   2. Device type.
   3. Present sensitivity selected.
   4. Sensor range (normal, dirty, etc.).
F. Sensors: The detector shall be comprised of two sensing elements including a smoke sensor and a carbon monoxide sensor.
   1. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
   2. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
   3. Each sensor shall be separately listed according to requirements for its detector type.

2.09 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances:
   1. Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
   2. Engraved with the word “FIRE” in minimum 1-inch-high letters.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a maximum sound pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
   1. Decibel levels shall be capable of being adjusted lower to a level required by code or occupant. Verify setting levels with AHJ prior to installation and testing. Typically set on lowest level.
   2. Device labeling requirements:
      a. For systems utilizing standard horn/strobe notification label all devices with the word “FIRE”.
      b. Devices shall be engraved in minimum 1-inch-high letters.
   3. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
   4. Mounting: Wall or ceiling mounted as indicated on plans.
   5. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   6. Flashing shall be in a temporal pattern, synchronized with other units.
   7. Strobe Leads: Factory connected to screw terminals.
   8. Mounting Faceplate:
      a. Ceiling: Factory finished, white.
      b. Wall: Factory finished, red.

C. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections. Combination devices shall be capable of having the horn silenced while the strobe remains active.

D. Exterior Devices: Exterior devices shall be exterior-rated weather-resistant type.

2.11 NOTIFICATION APPLIANCE CIRCUIT (NAC) PANEL

A. Supplemental Notification Appliance Circuit (NAC) panel shall offer 8.0 amps (6.0 amps continuous) of regulated 24-volt power. The NAC panel shall include the following features:
   1. Be capable of supplying (4) class ‘B’ circuits.
   2. Integral Charger: Charge up to 18.0 amp-hour batteries and support 24-hour standby.
   3. Input Triggers. Input trigger shall be Notification Appliance Circuit (from fire alarm control panel) or relay.
   4. Surface-mount back box.
   5. Ability to delay AC fail delay in accordance with applicable NFPA requirements.
   6. Power limited circuitry in accordance with applicable UL standards.
   7. Contain built-in synchronization and operates as sync follower or a sync generator. Provide in all spaces that contain three or more new or existing simultaneously-visible strobe devices.

2.12 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
   1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
   2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
   3. Rating: Verify with plans / and site conditions.

B. Material and Finish: Match door hardware.

2.13 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.14 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, UL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator recall, air handler shutdown, kitchen hood shunt-trip breaker, door access, nurse call system etc.

2.15 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   1. Factory fabricated and furnished by manufacturer of device.
   2. Finish: Paint of color to match the protected device.

2.16 CONDUIT AND WIRING

A. Wiring shall meet or exceed requirements of NEC Article 760.

B. Wiring Methods:
   1. Conduits shall be used for the following circuits:
      a. Between FACP and FAAP.
      b. Between FACP and power supply(s).
      c. Between FACP, Remote Communication Module, and telephone service point.
   2. Where conduits are required install cables in raceways. Conceal raceways except in unfinished spaces. Exposed cabling is not allowed.
   3. Where free air cabling is allowed, cables shall be installed in conduit in the following locations:
      a. Where cables are subject to physical damage or in corrosive atmospheres.
      b. Where cables are concealed within inaccessible walls or ceilings.
      c. In mechanical spaces and exposed storage areas.
      d. On existing unfinished walls below structural ceiling.
      e. Where otherwise required by a plan note.
   4. General Requirements:
      a. Material; Copper.
      b. Type: THHN/THWN in EMT conduit, or jacketed, fire alarm, red, plenum-rated cable.
      c. Insulation: 300V minimum, rated at 105°C.
   5. Initiating circuits (24V dc):
      a. Size: 16 AWG twisted shielded pair.
         1) If devices require a 24V dc power supply independent of communication wiring, provide 2-conductor 14 AWG from power supply.

6. Notification circuits (24V dc):
    a. Size: 2-conductor 14 AWG.
    b. Each circuit shall have 40% spare capacity.
    c. Voltage drop shall not cause any device to operate below its minimum rated voltage.
7. Control and Signal circuits (24V dc or 120V ac):
    a. Size:
        1) Power: 2-conductor 14 AWG 2-conductor.
        2) Control: 16 AWG twisted shielded pair.
    b. Do not run AC and DC circuits inside the same raceway.
8. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

2.17 FIRE ALARM PLACARD

A. Provide and/or update a fire alarm zone map next to the fire alarm control panel. Map(s) shall show what areas of the building are covered by the system(s) installed. Maps shall be accurate, legible and easily understood. They shall be laminated and permanently attached to the wall in the FACP/Riser room. The maps shall include the following minimum items:
1. Building layout.
2. Stairwell identification.
3. Location of fire-rated walls and their ratings.
4. Final room numbers (may differ from floor plan room numbers).
5. Knox Box location(s).
6. Adjacent streets, with designators.
7. North arrow.
8. Legend of symbols.
9. Date drawing was created.
10. FACP.
11. NAC panels.
12. Addressable fire alarm system device ID's.
13. Fire sprinkler riser locations.
14. Range hood suppression system locations.
15. Clean agent system locations.
16. VESDA system locations.
17. Dry pipe system locations.
18. Related information as requested by Fire Marshal.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. The fire alarm system shall be installed in a neat and workmanlike manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 is hereby adopted to define such workmanship and the installation of conductors and cables.

B. Provide all equipment, wiring, conduit, and junction boxes required for the installation of a complete and operating system in accordance with applicable local, state, and national codes, the manufacturers' recommendations, these plans and specifications.

C. Maintain existing or provide temporary fire alarm system in all other areas of the building as well as the area of remodel at all times. Maintain communication with monitoring / Central Station Control at all times.

D. Provide patching and painting of surfaces disturbed by removal of existing conduits or devices. Where devices are removed from ACT ceilings replace ceiling tiles; where devices are removed from sheetrock or plaster ceilings provide white coverplate over abandoned opening. Refer to Specifications 01 73 29 “Cutting and Patching” and 26 05 00 “Common Work Results for Electrical” for additional information.

3.02 EXAMINATION

A. Examine conditions for compliance with fire alarm components and ambient-temperature requirements for each component.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where components will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

3.03 EQUIPMENT AND CABLE INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit on concrete base with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

C. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
7. At rated doors locate ceiling smoke detector per the following criteria, in order of importance:
    a. Within five feet of door.
    b. Greater than three feet from mechanical diffusers.
    c. Centered on doorway.

D. Audible & Visible Notification Device settings:

1. Fire alarm installer shall be responsible for verifying appropriate decibel and candela ratings for each space. Where levels are uncomfortable or non-conforming to code the fire alarm installer shall adjust or replace unit such that appropriate levels are provided in each space.

E. NAC Panel Requirements:

1. Provide NAC panels as required to meet calculated loads.
2. Provide smoke detector (not shown on plans) at each NAC panel.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

1. Provide remote test switches for duct smoke detectors mounted 10’ or more above finished floor.
2. Provide duct extension as required if duct size is too small for detector installation. Coordinate with mechanical contractor.

G. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

H. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

I. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

J. Audible, Visible and Combination Alarm-Indicating Devices: Install as indicated on ceiling or on walls not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

L. Magnetic Door Holders: Mount to building structure to prevent loosening of device over time. Do not mount solely from wall material. Cut and patch existing walls as required.

M. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
4. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
5. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used.
6. Refer to 26 05 19 “Electrical Power Conductors” for additional cabling requirements.

3.04 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are UL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled. Devices not necessarily shown on plans.

1. Smoke dampers in air ducts of designated air-conditioning duct systems.
2. Alarm-initiating connection to elevator recall system and components.
3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
4. Supervisory connections at valve supervisory switches.
5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
6. Connections at doors with wanderguard to release during fire.
7. Connections at doors with access control to release during fire.
8. Connection with nurse call system. Initiating devices (smoke or CO-smoke detector) in resident rooms to have relay connection for interfacing between the two systems.

C. Provide electrical connections to the following equipment. Connections not necessarily shown on plans. Connect 120V power to emergency generator panels if available. Provide lock-out clamps for all 120V circuits.

1. 120V for fire/smoke dampers provided by Div 23.
2. 120V (or as shown on plans) for dry-type system compressor.
3. 120V for NAC panels.
4. 24V for door magnetic hold opens.

3.05 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Provide panel and circuit number labeling for FACP and all NAC panels.

B. Paint all fire alarm coverplates red.

C. Install and/or update fire alarm placard.

D. Install framed instructions in a location visible from fire-alarm control unit.

E. Final Owner Room Numbering: All labeling, identification or programming related to room numbering shall follow the Owner's final room numbering scheme. Obtain documentation of Owner's final room numbering prior to final labeling and/or programming. Identification of all systems shall utilize Owner's final room numbers.

3.06 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.07 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Architect/Engineer and authorities having jurisdiction.

B. Tests and Inspections:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Provide tests of notification devices in additions, areas of remodel, and areas adjacent to additions/remodeling.
3. Provide tests of initiation devices with verification of proper system response to added device initiation. Provide / verify address(es) of added devices are unique and existing devices and functionality have not been altered.
4. Visual Inspection: Conduct visual inspection prior to testing.
    a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
    b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
5. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
6. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
7. Test audible appliances for the private operating mode according to manufacturer's written instructions.
8. Test visible appliances for the public operating mode according to manufacturer's written instructions.
9. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Include test reports in Operation, Maintenance and Warranty Data Manuals.

F. Prepare test and inspection reports.

3.08 ADJUSTING/PROGRAMMING

A. On-Site Assistance: Provide on-site assistance in adjusting sensors and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

C. Coordinate all zone names and extension numbers with Owner prior to programming. Provide digital and hard copy of fire alarm initiation device address and notification circuit number with closeout documents.

3.09 DEMONSTRATION

A. Provide (1) hours training for Owner and maintenance personnel to adjust, operate, and maintain the fire alarm system and equipment. Video tape training session and deliver videotape to Engineer as part of the Closeout Documents. Refer to Division 01 Section “Demonstration and Training”.

3.10 CLEANING AND PROTECTION

A. Provide final cleaning and protection and maintain conditions in a manner acceptable to Installer, which ensures system being free from damage and deterioration at time of Substantial Completion.

END OF SECTION 28 31 11.01

SECTION 31 1000
SITE CLEARING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locater Service: Call 811 two business days prior to construction and notify all applicable utility companies.

D. Do not commence site clearing operations until temporary erosion and sediment control measures are in place.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance.

B. Protect site improvements to remain from damage. Restore damaged improvements to condition existing before start of clearing.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect remaining trees and shrubs from damage and maintain vegetation. Employ a licensed arborist to repair trees and shrub damage. Restore damaged vegetation. Replace damaged trees that cannot be restored to full growth, as determined by arborist.

E. Do not store materials or equipment or excavation within drip line of remaining trees.

F. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil bearing water runoff or airborne dust to adjacent properties and walkways.

G. Located, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

3.2 SITE CLEARING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

B. Strip topsoil. Stockpile topsoil that will be reused in the Work.

1. Stockpile surplus topsoil to allow for respreading deeper topsoil

C. Remove existing above and below grade improvements as indicated and as necessary to facilitate new construction.

D. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Neatly saw-cut length of existing pavement to remain before removing existing pavement.

E. In areas not to be further excavated, fill depressions resulting from site clearing. Place and compact satisfactory soil materials in 6-inch thick layers to density of surrounding original ground.

F. Dispose of waste materials, including trash, debris, and excess topsoil, off Owner's property. Burning waster materials on site is not permitted.

1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

SECTION 31 2200

GRADING (EXCAVATION & EMBANKMENT)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of topsoil.

B. Excavating and Embankment for street construction.

C. Rough grading the site for site structures.

D. Subgrade Preparation

E. Test Rolling

F. Finish grading.

1.2 REFERENCE STANDARDS

A. MNDOT Standard Specification for Construction - 2020 Edition.

PART 2 PRODUCTS

2.1 MATERIALS

A. Topsoil: Topsoil excavated on-site.
   1. Graded.
   2. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.

PART 3 EXECUTION

3.1 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

G. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.2 SUBGRADE PREPARATION

A. Shape and compact the subgrade prior to placing a base or surface course.

B. Compact the top 12 inches of the Subgrade in accordance with the requirements of the Method of Quality Compaction (MNDOT 2106.3G).

3.3 TEST ROLLING

A. Perform in accordance with the provisions of MNDOT 2111 except as modified below:
   1. Perform test rolling by making two passes over each strip covered by the width of a tire, with no unrolled areas between tire paths wider than 12 inches.

3.4 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.

C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

D. Place topsoil in areas where seeding is indicated.

E. Place topsoil where required to level finish grade.

F. Place topsoil to thickness as indicated.

G. Place topsoil during dry weather.

H. Remove roots, weeds, rocks, and foreign material while spreading.

I. Near plants spread topsoil manually to prevent damage.

J. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

K. Lightly compact placed topsoil.

L. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.5 FIELD QUALITY CONTROL

3.6 CLEANING

A. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 2313
SUBGRADE PREPARATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Shape and compact the subgrade prior to placing a base or surface course.

1.2 REFERENCE STANDARDS

A. MNDOT Standard Specification for Construction - 2020 Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Compact the top 12 inches of the Subgrade in accordance with the requirements of the Method of Quality Compaction (MNDOT 2106.3G).

B. Test rolling shall be performed in accordance with the provisions of MNDOT 2111 except as modified below:

1. The test rolling shall be performed by making two passes over each strip covered by the width of a tire. Unrolled areas between tire paths shall not be wider than 12 inches. No extra payment will be made for this work, incidental to Common Exc.

END OF SECTION

SECTION 31 2316.13
TRENCHING & BACKFILLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Backfilling and compacting for utilities outside the building to utility main connections.

1.2 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

1.3 SUBMITTALS

A. Samples: 10 pound sample of each type of fill; submit in air-tight containers to testing laboratory.

B. Compaction Density Test Reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. General Fill: Subsoil excavated on-site.
   1. Graded.
   2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.

B. Granular Fill - Fill Type Aggregate Bedding: Granular material, conforming to State of Minnesota Highway Department standard MNDOT(3149.2B1) except 100% passing 1".

2.2 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, testing of samples for compliance will be provided before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 31 2200 for additional requirements.

C. Locate, identify, and protect utilities that remain and protect from damage.

D. Notify utility company to remove and relocate utilities.

E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

F. Protect plants, lawns, rock outcroppings, and other features to remain.

G. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Engineer.

3.3 TRENCHING

A. In accordance with section 2600 - CEAM Standard Utilities Specification; 2023 Edition .

B. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

C. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

D. Do not interfere with 45 degree bearing splay of foundations.

E. Cut trenches wide enough to allow inspection of installed utilities.

F. Hand trim excavations. Remove loose matter.

G. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

H. Remove excavated material that is unsuitable for re-use from site.

I. Remove excess excavated material from site.

J. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

K. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Engineer.

3.4 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.5 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Slope grade away from building minimum 10% for 5 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

F. Reshape and re-compact fills subjected to vehicular traffic.

3.6 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated.

B. Utility Piping:
   1. Bedding: Use granular fill.
   2. Cover with general fill.
   3. Fill up to subgrade elevation.

3.7 TOLERANCES

A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.8 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection and testing.

B. Perform compaction density testing on compacted fill in accordance with Quality Compaction (MNDOT 2106).

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

END OF SECTION

SECTION 31 2323
FILL (EMBANKMENT)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Filling and compacting for paving.

B. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.2 RELATED REQUIREMENTS

A. Document Materials.: Geotechnical report; bore hole locations and findings of subsurface

B. Section 31 2200 - Grading (Excavation & Embankment): Removal and handling of soil to be re-used.

C. Section 31 2316 - Excavation: Removal and handling of soil to be re-used.

1.3 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

1.4 REFERENCE STANDARDS

A. MNDOT Standard Specification for Construction - 2020 Edition.

B. CEAM Standard Utilities Specifications - 2023 Edition.

C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2014.

D. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

1.5 SUBMITTALS

A. Samples: 10 pounds sample of each type of fill; submit in air-tight containers to testing laboratory.

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.

1.6 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. General Fill: Subsoil excavated on-site.
   1. Graded.
   2. Free of lumps larger than 3 inches, rocks larger than 3 inches, and debris.

B. Granular Fill - Fill Type Granular Borrow and/or Select Granular Borrow: Aggregate, conforming to State of Minnesota Highway Department standard.

C. Topsoil: Borrow.
   1. Unclassified.
   2. Graded.
   3. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.
   4. Acidity range (pH) of 6.1 to 7.8.
   5. Containing a minimum of 4 percent and a maximum of 25 percent inorganic matter.

2.2 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, testing of samples for compliance will be provided before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Identify required lines, levels, contours, and datum locations.

C. See Section 31 2200 for additional requirements.

D. Verify areas to be filled are not compromised with surface or ground water.

3.2 PREPARATION

A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.3 FILLING

A. Fill up to subgrade elevations unless otherwise indicated.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Granular Fill: Place and compact materials in equal continuous layers not exceeding 8 inches compacted depth.

F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.

G. Slope grade away from building minimum 10% for 5 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

H. Correct areas that are over-excavated.
   1. Load-bearing foundation surfaces: Use Fill Type Granular, flush to required elevation, compacted to 100 percent of maximum dry density.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.

I. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction in the upper 3 feet: 100 percent of maximum dry density.
   2. At other locations: 95 percent of maximum dry density.

J. Reshape and re-compact fills subjected to vehicular traffic.

K. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.4 FILL AT SPECIFIC LOCATIONS

3.5 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.

B. Top Surface of Filing Under Paved Areas: Plus or minus 1 inch from required elevations.

END OF SECTION

SECTION 32 1123
AGGREGATE BASE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aggregate base course.

1.2 REFERENCE STANDARDS

A. MNDOT Standard Specification for Construction, Section 2211- 2020 Edition.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aggregate Base as indicated in the plans: Conforming to MNDOT 3138 latest gradation tables or as modified by MNDOT's latest Special Provision at the time of bidding.

2.2 SOURCE QUALITY CONTROL

A. As per MNDOT 2211.3B or as modified by MNDOT's latest Special Provision at the time of bidding.

PART 3 EXECUTION

3.1 INSTALLATION

A. Construct aggregate base courses in accordance with the provisions of MNDOT 2211 except as modified below.
   1. Compact using the "Quality Compaction Method" described in MNDOT 2211.3D.2 or as modified by MNDOT's latest Special Provision at the time of bidding.

3.2 TOLERANCES

A. Comply with MNDOT 2211.3C or as modified by MNDOT's latest Special Provision at the time of bidding.

3.3 FIELD QUALITY CONTROL

A. Follow the procedures in MNDOT 2211.3D or as modified by MNDOT's latest Special Provision at the time of bidding.

B. Test roll compacted aggregate at surfaces that will be under paving.

END OF SECTION

SECTION 32 1216
BITUMINOUS PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Plant mixed asphalt pavement.

B. Bituminous tack coat.

1.2 REFERENCE STANDARDS

A. MNDOT Standard Specification for Construction - 2020 Edition.

PART 2 PRODUCTS

2.1 MATERIALS

A. Asphalt Binder Material: AASHTO M 322 (MSCR) and shall meet the PG requirements.

B. Tack Coat: Emulsified asphalt, in accordance with the MNDOT; Section 2357.

2.2 ASPHALT PAVING MIXES AND MIX DESIGN

A. Submit a proposed mix design of each class of mix for review prior to beginning of work in accordance with MNDOT; Section 2360.

B. Mix designations as indicated in the plans.

PART 3 EXECUTION

3.1 PLANT MIXED ASPHALT PAVEMENT

A. Install Work in accordance with MNDOT; Section 2360; except as modified herein:
   1. PAVEMENT SMOOTHNESS
      a. Pavement smoothness requirements of 2399 will not apply on this Project.
      b. The requirements of 2360.3.E Surface Requirements will apply.
   2. COMPACTION
      a. Compact the pavement to at least the minimum required maximum density values in accordance with the 1 Percent Reduced Table.
      b. MnDOT Table 2360-20 Longitudinal Joint Density Requirement is hereby deleted

B. Set manhole castings 0.5" below the final bituminous wearing surface.

C. Set gate valves castings 0.25" below the final bituminous wearing surface.

D. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.2 FIELD QUALITY CONTROL

A. Provide field inspection and testing. Take samples and perform tests in accordance with the MNDOT; Section 2360.

END OF SECTION

SECTION 32 1600

CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete curb and gutter, valley gutter, walks, driveway pavement/apron, truncated domes, and ped ramps.

1.2 REFERENCE STANDARDS

A. MNDOT Standard Specification for Construction, Section 2301, 2521, and 2531 - 2020 Edition.

B. All sidewalks, curb and gutters, and pedestrian facilities shall comply with the Americans with Diabilities Act (ADA) and MnDOT's Public Rights-Of-Way Access Guidelines (PROWAG).

1.3 SUBMITTALS

A. Product Data: Provide data on joint filler, admixtures, curing compound, and truncated domes.

B. Obtain a MNDOT Concrete office approved Concrete mix design prior to placing any concrete.

PART 2 PRODUCTS - NOT USED

2.1 CONCRETE MATERIALS

A. Concrete Materials: Provide in accordance with State of Minnesota Highways standards section 2461.

B. Aggregate: Class A aggregate as defined in MNDOT 3137 shall be used in all surface concrete for the project.

2.2 ACCESSORIES

A. Curing Compound: ASTM C 309, Type 2, Class B.

2.3 CONCRETE MIX DESIGN

A. Concrete mix design must meet the requirements in MNDOT 2301, 2521, 2531 and needs to be approved prior to placing any concrete.

PART 3 EXECUTION

3.1 SUBBASE

A. Prepare subbase in accordance with State of Minnesota Highways standards.

3.2 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.3 PLACING CONCRETE

A. Place concrete in accordance with State of Minnesota Highways standards.

B. All concrete curb & gutter, medians, ped ramps and concrete driveway pavement shall be completed according to MNDOT 2531.

C. All concrete sidewalk shall be completed according to MNDOT 2521.

D. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.

E. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.4 JOINTS

A. Align curb, gutter, and sidewalk joints.

B. Place 3/8 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components.
   1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
   2. Secure to resist movement by wet concrete.

C. Provide sawn joints: for all flatwork concrete.

D. Saw cut contraction joints 1/8 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.

END OF SECTION