

Harriman

York High School
Family Sciences
Classroom Renovation
York, Maine

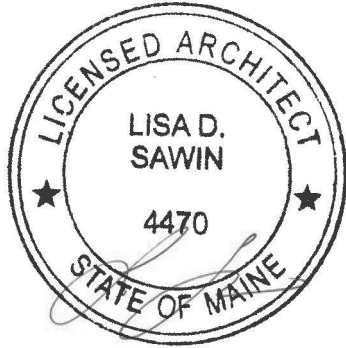
Project No. 22328

January 30, 2024

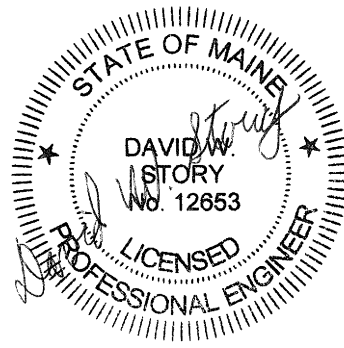
Construction Documents

PROFESSIONAL SEAL PAGE

Architect
HARRIMAN



Mechanical Engineer
HARRIMAN



Electrical Engineer
HARRIMAN



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YORK HIGH SCHOOL
FAMILY SCIENCES CLASSROOM RENOVATION
YORK, MAINE

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SECTION 1-A
INSTRUCTIONS TO BIDDERS
(PUBLIC SCHOOL PROJECT)

1. At the time of the opening of proposals, each bidder will be presumed to have inspected the site and to have read and be thoroughly familiar with the plans and contract documents, including all addenda. The failure or omission of any bidder to receive or examine any form, instrument, or document shall in no way relieve any bidder from any obligation in respect to his proposal. The Owner reserves the right to accept or reject any or all proposals as may best serve the interest of the Owner.
2. (a) General Contractors shall use the proposal form for General Contractor included in the specification. One (1) copy shall be filled out and signed and sent to the Owner in a sealed envelope to arrive on or before the time specified in the "Notice to Building Contractors" Section 2-A.

(b) Telegraphic proposal from the General Contractors will not be considered, but modifications by telegram of proposals already submitted will be considered, if received prior to the hour set for receipt of proposals. If the telegram discloses the amount of the proposal submitted, the proposal will be declared invalid.
3. Subject to the Owner's right, reserved herein, to accept or reject any or all proposals, the General Contractor will be selected on the basis of the sum of the lowest acceptable proposal plus such of the alternates as the Owner desires to use.
4. The Owner is exempt from the payment of Federal Excise Tax on articles not for resale and the Federal Transportation Tax on all shipments. The Contractor shall quote less these taxes.
5. Maine State Sales and Use Tax should not be included in your quotation as the Owner is exempt from the payment of such taxes. All Contractors and Sub-Contractors should refer to State of Maine, Bureau of Taxation "Sales and Use Tax Division" for latest bulletin covering Sales and Use Tax Regulations.
6. No proposal may be withdrawn during a period of thirty (30) calendar days immediately following the opening of the General contract proposals.
7. No contract may be assigned, sublet or transferred without the written consent of the Owner.
8. (a) All foreign corporations intending to do business in the State of Maine must comply with the provisions of Title 13-A M.R.S.A., Chapter 12. Any foreign corporation receiving notice of award of contract shall contact the Secretary of State for the purpose of complying with this statute.

(b) All individuals not residents of the State of Maine are subject to the provisions of Title 14, M.R.S.A., Section 704-A.

(c) It may be necessary for the General Contractor to submit to the Owner documentary evidence that the provisions have been complied with.

9. The selected General Contractor will be required to furnish a 100% performance bond and a 100% payment bond to cover the execution of his contract in conformity with the form of bonds shown in sections 2-C2 and 2-C3.

10. General Contractors may be required to furnish a statement of their business experience, record of accomplishments, and financial responsibility at the discretion of the Owner.

11. (a) The date of completion is stated in the proposal form section 2-B-1 and in the contract form section 2-E. If the Contractor finds it impossible to complete the work on or before the said date of completion, he may make a written request to the Owner for an extension of time setting forth therein the reasons for the request. If the Owner finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor he may extend the date of completion in such amount as, in his judgment, the conditions warrant. The said new date of completion shall then be in full force and affect the same as though it were the original date of completion.

(b) Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the Owner of administration of the Contract, inspection and supervision will be increased as the time occupied in the work is lengthened.

12. (a) The proposal shall be based on the materials, methods, equipment and products as specified.

(b) Any materials, methods, equipment and products not herein specified but deemed worthy of consideration by any General Contractor or Sub-Contractor, may be introduced by a separate letter attached to his proposal. He shall state the cost comparison with the specified methods, equipment and products and the reason for the suggested substitution.

(c) It shall be understood by the General Contractor or Sub-Contractor that the attached letter describing the proposed change will not be used in determining the low General or Sub-Contract proposal submitted unless the General or Sub-Contractor shall have submitted their list of proposed changes to the Designer 10 days prior to the date set for the receipt of their respective proposals, the Designer shall have issued an addendum related to the change(s) proposed, and the Contractor shall have received written approval by the Designer.

13. Employment Practices

(a) Listing of job vacancies; Executive Order No. 5, dated December 6, 1971, requires that "the Contractor, or any Sub-Contractor holding a contract directly under the

Contractor, shall, to the maximum feasible, list all its suitable employment openings with the Maine Employment Security Commission."

(b) "This provision shall not apply to employment openings which the Contractor proposed to fill from its own organization."

(c) Two copies of a "Quarterly Report of New Hires" shall be prepared by the 7th of January, April, July and October for the calendar quarter to which data pertains and sent to the local office of the Maine Employment Security Commission.

(d) A copy of the reporting form is attached to these Instructions to Bidders. These may be obtained from the nearest office of M.E.S.C. serving the area.

14. Code of Fair Practices; Executive Order No. 11, dated July 1, 1972, requires that every State contract for public works contain the following provisions: "During the performance of this contract, the Contractor agrees as follows:

(a) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religious creed, sex, national origin, ancestry or age. Such action shall include, but not be limited to the following: employment upgrading, demotions, transfers, recruitment or recruitment advertising; layoffs or terminations; rates of pay or other forms of compensation; and selection of training including apprenticeship.

(b) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor; state that all qualified applicants will receive consideration for employment without regard to race, color, religious creed, sex, national origin, ancestry or age.

(c) The Contractor will send to each labor union or representative of the workers with which he has a collective or bargaining agreement, or other contract or understanding, whereby he is furnished with labor for the performance of his contract, a notice, to be provided by the contracting department or agency, advising the said labor union or workers' representative of the Contractors commitment under this section and shall post copies of the notice in conspicuous places available to employees and to applicants for employment."

(d) The Contractor will cause the foregoing provisions to be inserted in all contracts for any work covered by this agreement so that such provisions will be binding upon each Sub- Contractor.

15. OSHA - Safety Regulations. This project is subject to compliance with all requirements of the Occupational Safety and Health Administration, Volume 36, No. 105 of the Federal Register, U.S. Department of Labor published Saturday, May 29, 1971 as amended.

16. Any proposal that contains an escalation clause will be invalid.

17. Any and all Designer interpretations and/or clarifications of bidding documents must be in the form of written addenda issued from the Designer office to all bidders who are on record at the Designer office not later than 72 hours prior to scheduled receipt of bids. (No verbal interpretations and/or clarifications shall be allowed as a substitute for written addenda.)
18. Questions by the bidder concerning alternate work descriptions/content/completeness and bidding process must be clarified with the Designer to assure the proper bidding and execution of all work intended under the alternate. This clarification must be in the form of a written addendum as described in item 19 above.
19. Preparation of General Contract Bid Proposal.
 - (a) General contract bidders are responsible for the completeness of their bid proposal on form issued with bidding document.
 - (b) Proposal must show cost of work specified including work specified; in any and all legally issued addenda.
 - (c) Any General contract proposal which fails to include the cost of work specified in an alternate may be declared informal if the Owner elects to include said alternate in the General contract.
 - (d) Proposal is to acknowledge all addenda that may have been legally issued. (Failure to acknowledge may be cause to have bid declared informal.)
 - (e) Indicate time for completion of the work, if required.
 - (f) Include corporate/partnership information as required.
 - (g) Proposal must be signed in ink.
 - (h) Proposal must be accompanied by required certified or cashier's check or a duly signed and executed bid bond.

SECTION 2-A

NOTICE TO BUILDING CONTRACTORS
(PUBLIC SCHOOL PROJECTS)

Sealed proposals in envelopes plainly marked, Proposal For:

York High School Family Sciences Classroom Renovation

Brief Job Description: The work consists of renovations of the family sciences kitchen and art classroom at York High School.

Addressed to: Mr. Chris Rynne
York School Department
469 US Route 1
York, ME 03909

Email: crynne@yorkschoools.org

Phone: (207) 363-3403 x10033

Proposals will be opened and read aloud at 2:00 pm on February 20, 2024, at the office of the Superintendent of Schools. Bids received after 2:30 pm will not be considered and will be returned unopened.

A mandatory pre-bid conference for General Contractors, to review project scope and bid requirements, will be held inside the main entrance of York High School on Friday, February 9, 2024 at 2:30 p.m. Attendance is required by General Contractors to bid the project.

The owner reserves the right to waive all formalities, and reject any and all proposals or to accept any proposal. Proposals shall be submitted upon the form provided by the architect.

General Contractors and Subcontractors can download Bid Documents from the BGS site at <https://www.maine.gov/dafs/brem/business-opportunities>.

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SECTION 2-B1

PROPOSAL FORM FOR GENERAL CONTRACTORS
(PUBLIC SCHOOL PROJECTS)

BIDDER: _____

TO: Mr. Chris Rynne
York School Department
469 US Route 1
York, ME 03909

A. Having carefully examined the form of contract, general conditions, special provisions and plans and specifications dated January 30, 2024, Prepared by: Harriman, Architects + Engineers for the York High School Family Sciences Classroom Renovation as well as the premises and conditions affecting the work, we the undersigned propose to furnish all labor, equipment, and materials necessary for and reasonably incidental to the construction and completion of this proposal for the amount of:

\$ _____

B. This proposal includes the following addenda to the drawings and specifications:

Addendum No. _____, Dated _____

Addendum No. _____, Dated _____

C. The undersigned agrees, if this proposal is accepted, to sign a contract and deliver it, along with the bonds and affidavits of all insurance specified within twelve (12) calendar days after the date of notification of such acceptance, except if the 12th day falls on a holiday, a Saturday or Sunday, then the conditions will be fulfilled if the required documents are received before 12 o'clock noon on the day following the holiday, or the Monday following the Saturday or Sunday, and as a guarantee thereof, herewith submits a certified or cashier's check or bid bond as required.

D. The undersigned agrees, if awarded the contract, to substantially complete the work on August 19, 2024 in accordance with Section 011000.

Signed _____

By _____

Address _____

NOTE: If bidder is a corporation, write State of incorporation, and if a partnership, give full names of all partners.

Contractor Bid Form

Bid Proposal Schedule of Values

Div.	Description of Work	Cost
1	General Requirements	\$
2	Existing Conditions	\$
3	Concrete	\$
4	Masonry	\$
5	Steel	\$
6	Carpentry	\$
7	Thermal and Moisture Protection	\$
8	Openings	\$
9	Finishes	\$
10	Specialties	\$
11	Equipment	\$
12	Furnishings	\$
13	Special Construction	\$
14	Conveying Equipment	\$
21	Fire Suppression	\$
22	Plumbing	\$
23	HVAC	\$
26	Electrical	\$
27	Communications	\$
28	Electronic Safety and Security	\$
31	Earthwork	\$
32	Exterior Improvements	\$
33	Utilities	\$

Subtotal: \$ _____

Mark-Ups

General Conditions	
Bonds and Insurances	

Subtotal: \$ _____

BASE BID SUBMISSION TOTAL: \$ _____

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SECTION 2-E

STATE OF MAINE
CONSTRUCTION CONTRACT
(Public School Project)

THIS AGREEMENT made the date of month in the year 2024 by and between the York School Department hereinafter called the *Owner*, and Contractor company name hereinafter called the *Contractor*.

WITNESSETH, That the *Owner* and the *Contractor* for the consideration hereinafter named agree as follows:

ARTICLE 1 SCOPE OF WORK

§ 1.1 The *Contractor* shall furnish all of the materials and perform all the work described in the specifications and shown on the drawings for the project entitled: York High School Family Sciences Renovation.

§ 1.2 The specifications and the drawings have been prepared by Harriman, acting as Designer and named in the documents as the Architect or Engineer. This firm has responsibilities for defining the scope of work governed by their agreement with the *Owner*, the specifications and the drawings, and the General Conditions and Special Provisions of the contract.

ARTICLE 2 COMPLETION DATE

§ 2.1 The work to be performed under this contract shall be completed on or before August 19, 2024. For each calendar day the project remains uncompleted \$750.00 shall be charged as liquidated damages.

ARTICLE 3 CONTRACT SUM

§ 3.1 The *Owner* shall pay the *Contractor* for the performance of the contract, subject to additions and deductions provided by approved Change Orders in current funds as follows: amount in words dollars and 00cents, \$0.00

ARTICLE 4 CONTRACT BONDS

§ 4.1 Contract bonds are not required if the contract amount is less than \$100,000 unless bonds are specifically mandated by the contract documents.

§ 4.2 On this project, the *Contractor* shall furnish the *Owner* the appropriate contract bonds in the amount of 100% of the contract amount.

ARTICLE 5 PROGRESS PAYMENTS

§ 5.1 The *Owner* shall make payments on account of the contract as provided therein as follows: Each month 95% of the value, based on contract prices of labor and materials incorporated in the work and of materials suitably stored at the site thereof up to the first day of that month, as certified by the Architect or Engineer.

§ 5.2 The *Owner* may cause the *Contractor* to be paid such portion of the amount retained hereunder as he deems advisable.

ARTICLE 6 FINAL PAYMENT

§ 6.1 Final payment shall be due 60 days after completion and acceptance of the work, provided the *Contractor* has submitted evidence satisfactory to the *Owner* that all payrolls, material bills and other indebtedness connected with the work has been paid.

ARTICLE 7 CONTRACT DOCUMENTS

§ 7.1 The General Conditions of the contract, Special Provisions, the written specifications and the drawings, and any Addenda, together with this agreement, form the contract; they are as fully a part of the contract as if hereto attached or herein repeated.

§ 7.2 Specifications: *date of issuance*

§ 7.3 Drawings: *each sheet number and title*

§ 7.4 Addenda: *each addenda number and date, or "none"*

ARTICLE 8 OTHER PROVISIONS

§ 8.1 None

The *Owner* and the *Contractor* hereby agree to the full performance of the covenants herein.

IN WITNESS WHEREOF the parties hereby execute this agreement the day and year first above written.

OWNER

CONTRACTOR

(Signature) _____ *(Date)*

(Signature) _____ *(Date)*

(Printed name and title)

(Printed name and title)

York School Department

(School Administrative Unit name)

(Contractor company name)

SECTION 3-A

STATE OF MAINE

STANDARD GENERAL CONDITIONS
AND
CONTRACT WORK

For

PUBLIC SCHOOL PROJECTS

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October 17, 1988

Rev. 12/21/92; 4/20/99, 11/08/01

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ARTICLE 1. DEFINITIONS

Whenever the following terms are used in these specifications or the contract, the intent and meaning shall be interpreted as follows:

Designer: The project Architect and/or Engineer whose name appears on the plans and/or specifications for the project, acting directly or through an authorized representative.

Bid Security: The security designated in the proposal, furnished by bidders as a guaranty of good faith to enter into a contract with the state, should a contract be awarded to that bidder.

Bidder: Any individual, partnership, or corporation submitting a proposal for the performance of the work described under the terms of the contract, acting directly or through a duly authorized representative.

Bureau: The Bureau of General Services.

Calendar Days: Consecutive days, as occurring on a calendar, taking into account the day of the week, month, year, and any religious, national or local holidays.

Change Order: A written agreement between the Owner and the Contractor, operating as a supplement to the contract, covering correction of: omissions, errors, and discrepancies between the plans and the proposal or estimates; or any alterations in the plans; or additional requirements; work, materials, and incidentals required to complete the construction of the project in an acceptable manner, and setting forth the basis of compensation for that supplemental work, if any. Before any change order modifies or becomes a part of the work, it must be duly signed by the Contractor, and the Owner, and approved by the Bureau of General Services and the Designer.

Clerk of the Works: The authorized representative of the Designer.

Contract: A written agreement between the Owner and the successful bidder, by which the Contractor is bound to perform the work specified, in accordance with plans, specifications, general conditions, and special provisions, that are a part of the contract documents, together with all supplemental agreements by which the Owner is bound to compensate the Contractor at mutually established and accepted rates or prices.

Contract Bond: The approved forms of security furnished by the Contractor and his surety, or sureties, which guarantee the faithful performance of all the terms of the contract and the payment of all bills, for labor, materials and equipment by the Contractor.

Contract Documents: The contract documents consist of the contract, general conditions, special provisions, the plans and specifications including all addenda, change orders, and all other modifications thereof, that were incorporated in the documents

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subsequent to their execution.

Contractor: The individual, partnership, or corporation undertaking the execution of the general contract work under the terms of the contract with the Owner, acting directly or through a duly authorized representative.

Director of the Bureau of General Services: The State Director of the Bureau of General Services or his/her duly authorized representative.

Final Completion: The stage of the Work when the Work has been fully completed in accordance with the terms and conditions of the Contract Documents.

Owner: School Administrative Unit, acting through its duly authorized representative.

Owner's Representative:

Plans: All official drawings or reproductions of drawings pertaining to the work provided for in the contract and such working plans as may be furnished or approved by the Owner or Designer from time to time.

Project: The entire improvement proposed by the Owner to be constructed in part or in whole pursuant to these specifications and contract documents. Where the word "Job" appears it shall mean the project.

Proposal or Bid: The written offer of the bidder, on a form prescribed to perform the work specified.

Provide: The word "provide" shall mean, "furnish and install," including connections to services if required, unless specified otherwise.

Sub-Contractor: The individual, the firm or corporation undertaking the execution of any part of the work under the terms of the contract by virtue of a written agreement between itself and the Contractor.

Substantial Completion: 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 the Owner can occupy or utilize the Work for its intended use. Minor corrections and repairs that can be performed while the Owner has occupied the building and without undue annoyance to personnel will be acceptable under the definition of Substantial Completion. It shall also include major final cleaning required under the Contract, removal of all surplus equipment and material not required for completion of remaining work, and the placement of remaining materials and equipment in convenient locations as approved by the Owner.

Superintendent: The representative of the Contractor, authorized by the Contractor to receive and fulfill instructions from the Designer.

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Supplemental Agreement: A supplemental agreement is any agreement entered into between the Contractor and the Owner with the approval of the Bureau and the Designer subsequent to the execution of the contract.

Surety: The individual, partnership, or corporation who is bound jointly and severally with the Contractor and sub-Contractor to insure his faithful performance of the contract and for his payment of the bills for labor, materials and equipment by the Contractor and Sub-Contractors.

Work: See Project.

ARTICLE 2. INTENT, CORRELATION AND EXECUTION OF DOCUMENTS

The intent of the Contract Documents is to prescribe a complete work or improvement. The Plans, including all revisions, General Conditions for Contract Work, Special Provisions, Instructions to Bidders, Proposal, Contract, Contract Bonds, and all other sections of the specifications, including all addenda, all dated and on file in the Bureau of General Services, prior to the time set for receiving proposals as prepared by the Designer, shall each become a part of the Contract Documents, and all proposals must be based on a full compliance therewith. Any Supplemental Agreements entered into subsequent to the Contract will become a part of said Contract.

The contract documents are complementary, and what is called for by any one shall be as binding as if called for by all. The intention of the documents is that, unless otherwise specified, the Contractor shall furnish all labor, materials, equipment, items, articles, tools, transportation, insurance, services, necessary supplies, operations or methods and incidentals that may be reasonably required to construct and complete the project, facility or improvement in a manner necessary for the proper execution of the work. Any deviations from the plans which may be required by the exigencies of the construction, or because of error, will in all cases, be determined by the Designer, and authorized in writing subject to approval by the Owner and Bureau of General Services. Materials or work described in words, which so applied, have a well-known technical or trade meaning shall be held to refer to such recognized standards. Since the plans and specifications cover the dimensions and features of the work and do not set forth the analysis of the design, it is the duty of the Contractor fulfilling them to ascertain the true intent in any case where it is doubtful.

Work not covered under any heading, section, branch, class or trade of the specifications, shall not be supplied unless it is shown on the drawings or is reasonably inferable there from as being necessary to produce the intended results.

The Contractor shall take no advantage of any apparent error or omission in the plans and specifications, and the Designer shall be permitted to make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the plans and specifications. Where errors or omissions appear in the contract documents, the Contractor shall promptly notify the Designer in writing of such errors or omissions. Inconsistencies in the contract documents are to be reported before proposals are received, whenever found.

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Should the Drawings or the Specifications disagree in themselves or with each other, the Contractor shall provide the better quality or greater quantity of work and/or materials unless otherwise directed by written addendum to the Contract Documents.

The Contractor shall, upon his acceptance of a contract and before commencing work, contact the Designer and request a preconstruction conference. The purpose of this conference shall be as follows:

1. To introduce the members of the Designer's firm and the representative of the Owner and define their responsibilities in connection with this project.
2. To emphasize any special provisions applicable to the project.
3. To establish the work progress schedule and set up procedures for prompt review of all required shop drawings. If the Contract Sum exceeds \$ 10,000,000, the Contractor shall supply the Owner with the planned Critical Path Method ("CPM") schedule prior to the submission of the first payment requisition. The Contractor shall supply the Owner monthly with CPM "as built" schedule updates. The update shall include the dates of activities' start and completion; percent of work remaining for activities started but not completed; narrative report indicating a listing of monthly progress; any changes to critical path activities from the prior update; sources of delay and potential problems; and work planned for the next month. If any date is more than fifteen (15) days behind, the Contractor must submit a recovery schedule. When a Change Order is proposed, the Contractor must identify all schedule impacts which result from the Change Order.
4. To provide the Contractor with opportunity to discuss points of doubt and any apparent inconsistencies noted in the plans and specifications before proceeding to purchase material or execute the work.

During the further progress of work, regular meetings will be held at time intervals appropriate in the judgment of the Designer to review the work progress schedule, general project progress and any other questions, which might affect the execution of this contract.

ARTICLE 3: DETAIL DRAWINGS AND INSTRUCTIONS

The Designer shall furnish, with reasonable promptness, additional instructions by means of drawings or otherwise, that are necessary for the proper execution of the work. All such drawings and instruction shall be consistent with the contract documents, shall be true developments thereof, and shall be reasonably inferable there from.

The work shall be executed in conformity therewith and the Contractor shall do no work without proper drawings and instructions except as allowed by Article 13.

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Immediately after being awarded the contract, the Contractor shall prepare an estimated progress schedule and submit same for Designer's approval. It shall indicate the dates for starting and completion of the various stages of construction.

ARTICLE 4: COPIES FURNISHED

Unless otherwise provided in the contract documents the Contractor will be furnished, free of charge, 10 copies of all drawings, and specifications.

ARTICLE 5: SHOP DRAWINGS

The Contractor shall check and verify all field measurements and shall submit with such promptness as to cause no delay in the Contractor's own work or in that of any other Contractor, adequate copies, checked and approved by the Contractors of all shop drawings and schedules required for the work of the various trades. The Designer shall check and approve, with reasonable promptness, such scheduled drawings only for conformance with the design concept of the project and compliance with the information given in the contract documents. The Contractor shall make any corrections required by the Designer, and shall file with the Designer two corrected copies, and shall furnish such other copies as may be needed. The Designer's approval of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from drawings or specifications, unless the Contractors have, in writing, called the Designer's attention to such deviations at the time of submission and secured the Designer's written approval; nor shall it relieve the Contractors from responsibility for errors in shop drawings or schedules.

ARTICLE 6: DRAWINGS AND SPECIFICATIONS

The Contractor shall keep, in good order, one copy of all drawings and specifications on the work, which will be made available to the Designer and to his representative.

ARTICLE 7: OWNERSHIP OF DRAWINGS

All drawings, specifications and copies thereof furnished by the Designer are the property of the Designer. They are not to be used on other work without written permission from the Designer, and, with the exception of the signed contract set, are to be returned to the Designer upon request, or at the completion of the work.

ARTICLE 8: SAMPLES

The Contractor shall furnish for review, with reasonable promptness, all samples as directed by the Designer. The Designer shall check and review such samples, with reasonable promptness, only for conformance with the design concept of the project and for compliance with the project and for compliance with the information given in the contract documents. The work shall be in accordance with reviewed samples.

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ARTICLE 9: MATERIALS, APPLIANCE, EMPLOYEES

Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation and facilities necessary for the execution and completion of the work.

Whenever an article or material is defined by describing a proprietary product, or by using the name of a manufacturer, the term "Or Approved Equal", if not inserted, shall be implied. The specific article or material mentioned shall be understood to establish minimum standards as to the type, function, standard of design, durability, efficiency and quality desired and shall not be construed to exclude other manufacturers' products of comparable quality, design and efficiency.

Materials and models of items, which the Contractor alleges to be equal to the materials and methods of items named in the specifications, shall be subject to the written approval by the Designer. If the alleged equals are to receive consideration in the bid award, written approval shall be received from the Designer at least ten days prior to the established bid opening dates. The use of alternate items will not be permitted without the approval of the Owner and Designer. All approved substitutions shall be in writing and approved by the Designer. The Contractor shall not be relieved of the responsibility to furnish articles or materials equal in quality, design and efficiency to those specified because of the approval of such alternate items by the Designer. The Designer's approval or rejection of a proposed substitution may be based on any of the previous considerations, and his decision may or may not express reasons for rejection and shall be final. Requests for substitutions shall originate and be submitted by the Contractor, not a Sub-Contractor. The materials or equipment shall be sufficiently described to enable the Designer to easily identify salient features.

Any material or products not specified in the bidding documents but being worthy of consideration may be introduced by the Contractor, or Sub-Contractor. The Contractor's submission shall include a cost comparison with the specified material and the reason for the suggested substitution. The basic proposal shall be as specified.

It shall be understood by the general Contractor or Sub-Contractor that the attached letter describing the proposed changes will not be used in determining the low general Contractor or Sub-Contractor proposal submitted, unless the general Contractor or Sub-Contractor has submitted its list to the Designer 10 days prior to the date set for the receipt of their respective proposals and has received written approval by the Designer five days prior to the opening of the bid.

The Contractor shall guarantee his work against any defects in workmanship and materials for a period of one year from the date of the written acceptance of the project.

Materials and equipment shall be new, free from defects, perfect and complete, unless otherwise stipulated. Materials or equipment specified or shown on the drawings shall be applied or installed according to the directions with the manufacturer, or the recommendations of an association dealing primarily with the material, unless specifically designated otherwise. The scope of the direction furnished shall include the application of

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experienced personnel to each trade involved. In no case shall the installation be below the standard recommended by the manufacturer or association.

The Contractor shall be responsible to the Owner for the suitability of materials and equipment furnished and for full compliance with the specification.

The Contractor shall promptly pay all his employees when their pay is due, shall promptly pay when due all bills for materials, supplies and services going into the work, and all bills for insurance, workmen's compensation coverage, federal and state unemployment compensation, and Social Security charges applicable to said project. Before final settlement is made, the Contractor shall furnish to the Owner affidavits that all said payments have been made.

The Contractor shall at all times enforce strict discipline and good order among his employees, and shall not employ on the work any unfit person or anyone not skilled in the work assigned to him.

ARTICLE 10: ROYALTIES AND PATENTS

The Contractor shall, for all time, secure to the Owner the free and undisputed right to the use of any and all patented articles or methods used in the work and shall defend at his own expense any and all suits for infringement or alleged infringement of such patents, and in the event of adverse award under patent suits, the Contractor shall pay such awards and hold the Owner harmless in connection with any patent suits that may arise as a result of installations made by the Contractor, or to any awards made thereunder.

ARTICLE 11: SURVEYS, PERMITS, LAWS, TAXES AND REGULATIONS

The Owner shall furnish all surveys unless otherwise specified.

Permits and licenses necessary for the prosecution of the work shall be secured and paid for by the Contractor. Easements for permanent structures or permanent changes in existing facilities shall be secured and paid for by the Owner, unless otherwise specified.

The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the drawings and specifications are at variance therewith, the Contractor shall promptly notify the Designer in writing and any necessary changes shall be adjusted as provided in the contract for changes in the work. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations and without such notice to the Designer, the Contractor shall bear all costs arising there from.

Adherence to the Code of Federal Regulations 29 CFR Part 1926 and 29 CFR Part 1910 as adopted by the State Board of Occupational Safety and Health is required by statute.

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The State is exempt from the payment of Federal Excise Taxes on articles not for resale and for the Federal Transportation Tax on all shipments. All quotes from the Contractor and Sub-Contractors shall be free of these taxes. The State is exempt from the payment of Maine State Sales and Use Taxes. All quotes from the Contractor and Sub-Contractors shall be free of these taxes.

In execution and performance of the Contract, the Contractor and all subcontractors agree to be aware of and to comply with the requirements and regulations of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et. seq.)

ARTICLE 12: LABOR AND WAGES

All Contractors and Sub-Contractors shall conform to the labor laws of the State of Maine, and all other laws, ordinances and legal requirements affecting the Work in Maine.

In the employment of laborers, preference shall first be given to residents of the State of Maine who are qualified to perform the work to which the employment relates, and if they cannot be obtained in sufficient numbers, then to citizens of the United States, who may reside in other states.

ARTICLE 13: CONDITIONS AND CARE OF SITE AND PROTECTION OF THE WORK

The Contractor shall continuously maintain adequate protection of all work from damage and shall protect the property from injury or loss for the duration of this contract, and shall make good any such damage, injury or loss. He shall adequately protect adjacent property as provided by law and the contract documents.

The Contractor shall take all necessary precautions for the safety of employees on the work, and shall comply with all applicable provisions of federal, state and municipal safety laws and building codes, and shall prevent accidents or injury to persons on, about or adjacent to the premises where the work is being performed. The Contractor shall erect and properly maintain all necessary safeguards for the protection of workmen and the public at all times, as required by the condition and progress of the work, and shall post danger signs warning against all hazards created by the construction process, such as (but not limited to) protruding nails, hoists, well holes, elevator hatchways, scaffolding, window openings, stairways and falling materials. The Contractor shall designate a responsible member of his organization on the work, whose duty shall be the prevention of accidents. The Contractor shall report the name and position of any person so designated to the Designer.

The Contractor shall return to conditions existing prior to the start of work on the project, all aspects of the site that have not been altered, removed, or otherwise changed permanently by the work. The Contractor shall protect all existing buildings, structures, or other features from damage by any operation in connection with the project. Utilities encountered shall be protected and maintained in service until removed or abandoned.

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The Contractor shall exercise care in his work around such utilities as may be shown on the plot plan or otherwise found. Such utilities are not to be moved, replaced or abandoned.

The Contractor shall protect existing trees, and other aspects of the site, which will remain a permanent part of the site from damage during grading, excavation, filling, trucking, etc. If necessary, tree trunks shall be boxed, and barricades set up at sufficient distance to prevent damage to major tree branches.

Should the work or material of this or any other Contractor employed by the Owner become damaged when reasonably protected, the same shall be replaced by the Contractor causing the damage at no expense to the Owner.

In an emergency potentially affecting health or life or of serious damage to property or of adjoining property, the Contractor, without special instruction or authorization from the Designer or Owner, is hereby permitted to act on his own discretion, to prevent such threatened loss or injury, and the Contractor shall so act, without appeal, if so authorized or instructed. Any compensation claimed by the Contractor on account of emergency work, shall be determined by agreement.

ARTICLE 14: INSPECTION OF WORK

The Designer and his representatives, the Bureau of General Services representatives and the Owner, shall at all times have access to the work whenever it is in preparation or progress. The Contractor shall provide proper facilities for such access and for inspection.

If the specifications, the Designer's instructions, laws, ordinances or any public authority require any work to be specially tested or approved, the Contractor shall give the Designer timely notice of its readiness for observation by the Designer or inspection by another authority, and if the inspection is by another authority than the Designer, on the date fixed for such inspection, required certificates of inspection shall be secured by the Contractor. Observations by the Designer shall be promptly made, and where practicable, prior to work is covered or buried. If any work which will ultimately be covered, is covered prior to approval or consent of the Designer, it must, if requested by the Designer, be uncovered for examination at the Contractor's expense.

Re-examination of questioned work may be ordered by the Designer, and, if so ordered, the work must be uncovered by the Contractor. If such work were found in accordance with the contract documents, the Owner shall pay the cost of the reexamination and replacement. If such work were found not in accordance with the contract documents, the Contractor shall pay such cost, unless it is found that the defect in the work was caused by a Contractor employed as provided in Article 32, and in that event the Owner shall pay such cost.

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The Bureau of General Services, through its representatives shall make periodic inspections of the work during the course of construction and make recommendations to the Designer, when employed. The Designer shall provide adequate inspection of materials, equipment, methods and changes in plans on all projects under his supervision.

ARTICLE 15: SUPERINTENDENCE: SUPERVISION

The Contractor shall have, during the progress of all work, a competent superintendent and any necessary assistants. The superintendent shall not be changed except with the consent of the Owner unless a superintendent proves to be unsatisfactory to the Contractor and ceases to be in his employ. The superintendent shall represent the Contractor and all directions given to the superintendent in the absence of the Contractor shall be as binding as if given directly to the Contractor. Important directions shall be confirmed in writing to the Contractor. Other directions shall be confirmed on written request in each case. The Designer shall not be responsible for the acts or omissions of the superintendent or his assistants.

The Contractor shall give efficient supervision to the work using his best skill and attention. He shall carefully study and compare all drawings, specifications and other instructions and shall at once report to the Designer any error, inconsistency or omission which he may discover, but he shall not be liable to the Owner for any damage resulting from any errors or deficiencies in the contract documents or other instructions by the Designer.

ARTICLE 16: CHANGES IN THE WORK

The Owner reserves the right to increase or decrease any or all of the items of work indicated in the plans, proposal, and contract, or the elimination of any one or more of such items, without invalidating the contract. As the work progresses, the Owner may make such alterations in the plans, in the character of the work, or in the specified coordination of two or more concurrent contracts, as may be considered necessary or desirable in order to complete the construction. Such changes shall in no way invalidate the contract. All such work shall be executed under the conditions of the original contract except that any claim for extension of the time caused thereby shall be adjusted at the time of the ordering of such change.

In giving instructions, the Designer shall have authority to make minor changes in the work, not involving extra cost, and not inconsistent with the purposes of the building or project, but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a duly signed change order.

Should the Contractor encounter during the progress of the work, latent conditions at the site materially differing from those shown on the drawings or in the specifications, or unknown conditions of an unusual nature differing materially from those already encountered in such work, the attention of the Designer shall be immediately called for such conditions before they are disturbed. The Designer shall promptly investigate the conditions and if they do so materially differ, the contract shall, with the approval of the Owner and the Bureau be modified by a change order to provide for any increase or decrease in cost resulting from such conditions

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Should such alterations be productive of increased unit cost, or result in decreased unit cost to the Contractor, a fair and equitable sum therefore shall be agreed upon in writing before such work is begun, and shall be added to or deducted from the contract amount, as the case may be, by means of a written change order. The change order shall state the nature of the change, the location, the itemized estimate of unit quantities, the basis for payment, and the reason for the change. Such change order to be on approved forms.

When the change order has been properly signed by all parties and encumbered, it shall become a part of the contract.

The value of any such extra work or change shall be determined in one or more of the following ways:

- A. By estimate and acceptance in a lump sum.
- B. By unit prices named in the contract or subsequently agreed upon.
- C. By cost and percentage or by cost and a fixed fee.

If none of the above methods is agreed upon, the Contractor, provided he receives an order as above, shall proceed with the work.

Under case (C.), he shall keep and present in such form as the Designer may direct, a correct account of the cost, together with vouchers. In any case, the Designer shall certify to the amount, including reasonable allowance for overhead and profit, due to the Contractor. Pending final determination of value, payments on account of changes shall be made on the Designer's certificate.

If the price of a change order cannot be agreed upon, nothing contained herein shall prevent the Designer, with approval from the Owner and BGS, from directing the Contractor to make a change in the work, with the price to be determined on either a cost and percentage basis or under the dispute resolution provision of this contract.

If the price of a change order cannot be agreed upon, an Owner and/or Designer initiated Construction Change Directive can order a change in the work prior to an agreement on the adjusted Contract Sum or Contract Time. The Cost of the work is to be determined by: 1) a cost and percentage basis 2) lump sum 3) unit prices or 4) under the Dispute Resolution provision of this contract.

When the subparagraphs (A) and (C) above are used to determine the value of the work, the allowance for overhead and profit combined, included in the total expense to the Owner, shall be based upon the following schedule:

For the Contractor, for any work performed by his own forces, 20% of the cost; For each Sub-Contractor, for work performed by his own forces, 20% of the cost; For the Contractor, for work performed by his Sub-Contractor, 10% of the amount due the Sub-Contractor.

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Cost shall be limited to the following: Cost of materials, cost of delivery, cost of labor, including Social Security, old age and unemployment insurance (labor cost may include a pro ratio share of foremen's time, only in case an extension of contract time is granted on account of the change); workmen's compensation insurance; rental value of power tools and equipment.

Overhead shall include the following; bond premium, supervision, wages of timekeepers, watchmen and clerks, small tools, incidental, general office expense, and all other expenses not included in "cost".

If the net value of a change results in a credit from the Contractor or Sub- Contractor the credit given shall be the net cost without overhead or profit. The cost as used herein shall include all items of labor, materials and equipment.

ARTICLE 17: CLAIMS FOR EXTRA COST

If the Contractor claims that any instructions by drawings or otherwise involve extra cost under this contract, he shall give the Designer written notice thereof within 10 days after the receipt of such instructions, and in any event before proceeding to execute the work, except in emergency endangering life or property, and the procedure shall then be as provided for in Section 16, "changes in work." No such claim shall be valid unless so made.

ARTICLE 18: DEDUCTIONS FOR UNCORRECTED WORK

If the Designer and Owner deem it inexpedient to correct work injured or done not in accordance with the contract, an equitable deduction from the contract amount shall be made therefore.

ARTICLE 19: DELAYS AND EXTENSION OF TIME

If the Contractor is delayed at any time in the progress of the work by any act or neglect of the Owner or the Designer, or of any employee of either, or by any separate Contractor employed by the Owner, or by changes ordered in the work or by strikes, lockouts, fire, unusual delay in transportation, unavoidable casualties Or by causes beyond the Contractor's control, or by any cause which the Designer shall decide to justify the delay, then the time of completion shall be extended for such reasonable time as the Designer may decide. Inclement weather or other natural causes shall not be reason to allow additional time under this contract.

No such extension shall be made for delay occurring more than seven days before claim therefore is made in writing to the Designer. In case of a continuing cause of delay, only one claim is necessary.

If no schedule or agreement stating the dates upon which drawings shall be furnished is made, then no claim for delay shall be allowed on account of failure to furnish drawings until two weeks after demand for such drawings and not then unless such claim be

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reasonable.

This article does not exclude the recovery of damages for delay by either party under other provisions in the contract document. The amount of Contractor's delay damages shall be limited to the Costs, overhead and profit items enumerated in Article 16. Recovery of delay damages is conditioned upon compliance with the notice requirements of Article 17.

ARTICLE 20: CORRECTION OF WORK

The Contractor shall promptly remove from the premises all work condemned by the Designer as failing to conform to the contract, whether incorporated or not, and the Contractor shall promptly replace and re-execute his own work in accordance with the contract and without expense to the Owner and shall bear the expense of making good all work of other Contractors destroyed or damaged by such removal or replacement.

If the Contractor does not remove such condemned work within a reasonable time, fixed by written notice, the Owner may remove it and may store the material at the expense of the Contractor. If the Contractor does not pay the expenses of such removal within ten days time, thereafter, the Owner may, upon ten days written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Contractor.

The Contractor shall remedy any defects due to faulty materials or workmanship and pay for any damage to other work resulting therefrom, which shall appear within a period of one year from the date of final payment, or from the date of the Owner's substantial usage or occupancy of the project, whichever is earlier, and in accordance with the terms of any special guarantees provided in the contract. The Owner shall give notice of observed defects with reasonable promptness. All questions arising under this article will be decided by the Designer, notwithstanding final payment.

ARTICLE 21: OWNER'S RIGHT TO DO WORK

If the Contractor should neglect to prosecute the work properly or fail to perform any provisions of this contract, the Owner, after three days written notice to the Contractor may, without prejudice to any other remedy may make good such deficiencies

and may deduct the cost thereof from the payment; then or thereafter due the Contractor, provided, however, that the Designer shall approve both such action and the amount charged to the Contractor.

ARTICLE 22: OWNER'S RIGHT TO TERMINATE CONTRACT

If the Contractor should be adjudged bankrupt, or if the Contractor should make a general assignment for the benefit of its creditors, or if a receiver should be appointed on account the Contractor's insolvency, or if the Contractor should persistently or repeatedly

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refuse or should fail, except in cases for which extension of time is provided, to supply enough properly skilled workmen or proper materials or if the Contractor should fail to make prompt payment to Sub-Contractors or for material, or labor, or persistently disregard laws, ordinance or the instructions of the Designer, or otherwise be guilty of a substantial violation of any provision of the contract, then the Owner, upon the certificate of the Designer that sufficient cause exists to justify such action, may without prejudice to any other right or remedy and after giving the Contractor and the Contractor's surety seven days written notice, terminate the employment of the Contractor and take possession of the premises and of all materials, tools and appliances thereon and finish the work by whatever method the Owner may deem expedient. In such case the Contractor shall not be entitled to receive any further payment until the work is finished. If the unpaid balance of the contract amount shall exceed the expense of finishing the work including compensation for additional Designer, managerial and administrative services, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the Contractor shall pay the difference to the Owner. The expense incurred through the Contractor's default, shall be certified by the Designer.

ARTICLE 23: THE CONTRACTOR'S RIGHT TO STOP WORK OR TERMINATE CONTRACT

If the work should be stopped under an order of any court, or other public authority, for a period of thirty days, through no act or fault of the Contractor or of anyone employed by him, then the Contractor, may, upon seven days written notice to the Owner and the Designer, terminate this contract and recover from the Owner, payment for all work executed and any proven loss sustained upon any plant or materials and reasonable profit and damage.

Should the Designer fail to issue any certificate for payment, through no fault of the Contractor, within seven days after the Contractor's formal request for payment or if the Owner should fail to pay to the Contractor within 30 days after presentation, any sum certified by the Designer, then the Contractor may, upon seven days' written notice to the Owner and the Designer, stop the work or terminate this Contractor as set out in the preceding paragraph.

ARTICLE 24: PAYMENTS

The Contractor shall, before the first application for payment, submit to the Designer in triplicate a "contract cost breakdown" form acceptable to the Designer, if required, this form shall be supported by such evidence as to its correctness as the Designer may direct and, shall be reviewed by the Designer and unless found to be in error, used as a basis for payments.

The Contractor shall submit to the Designer an application for each payment on the latest revision of the BGS "Requisition for payment" form, and, if required, receipts or other vouchers, showing his payments of materials and labor, including payments to sub-Contractors as required by Article 34.

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Application for payment as the Work progresses may be made of the Owner but no more often than once a month, unless due to unusual circumstance the Owner may approve more frequent payment. Said requisition for payments shall be based on the proportionate quantities of the various classes of work completed or incorporated in the Work, in accordance with the Work progress schedule and the value thereof determined from the contract cost breakdown. Payments, upon authorization of the Designer, may be made on account of materials not incorporated in the Work but delivered and suitably stored at the site. Such payments shall be conditioned upon submission by the Contractor of bills of sale, or such other procedure as will adequately protect the Owner's interest including applicable insurance.

In the event any materials are delivered but not yet incorporated in the Work, have been included in any said "Requisition for Payment" and payment thereon made and said materials thereafter deteriorate, become damaged or destroyed or for any reason whatsoever become unsuitable or unavailable for use in the Work, then the full amount allowed therefore in any previous "Requisition for Payment", shall be deducted from the gross value of any subsequent payment or final payment unless the Contractor shall satisfactorily replace said material.

After said "Requisition for Payment" has been prepared by the Contractor in the required number of copies, it shall be submitted to the Designer for review. The Designer shall verify and approve the "Requisition for Payment", and forward all copies to the Owner for processing for payment by the Owner.

No certificate issued nor payment made to the Contractor, nor partial or entire use or occupancy of the Work by the Owner, shall be an acceptance of any Work or materials not in accordance with this contract. Except for those claims previously made by either party and still unsettled, the making and acceptance of the final payment shall constitute a waiver of all claims by the Owner, other than those arising from unsettled liens, those not complying with the requirements of the plans and specifications, those covered by warranties, and of all claims by the Contractor.

Title 5 M.R.S.A. Section 1746 as amended provides that in any contract awarded for any public improvement, the State shall withhold 5% of the money due the Contractor until the project under the contract has been accepted by or for the State, except that when the contract has been *substantially completed* the State may, upon request, further reduce the amounts withheld if it deems it desirable and prudent, or except when the Contractor elects to deposit with the Treasurer of the State certain Government Bonds as provided in Chapter 437, Public Laws of 1967.

With each monthly requisition the Contractor shall release and indemnify the owner from and against all liens on the project through the requisition date and shall supply partial lien waivers from all subcontractors through the date of the prior requisition.

All payments to be made in accordance with Title 10 MRSA Chapter 201-A "An Act to Ensure Prompt and Equitable Payment for Construction Services".

ARTICLE 25. PAYMENTS WITHHELD

The Designer may withhold or, on account of subsequently discovered evidence, nullify the whole or a part of any certificate to such extent as may be necessary in his reasonable opinion to protect the Owner from loss on account of:

- A. Defective work not remedied.
- B. Claims filed or reasonable evidence indicating probable filing of claims.
- C. Failure of the Contractor to make payments properly to Sub-Contractors for materials or labor.
- D. A reasonable doubt that the contract can be completed for the balance then unpaid.
- E. Damage to another Contractor.
- F. Damage to the premises or Work.
- G. Failure to carry out the Work in accordance with the Contract Documents.

When the above grounds are removed, payments shall be made for amounts withheld because of them.

ARTICLE 26. CONTRACTOR'S INSURANCE REQUIREMENTS

The Contractor shall not commence work under this contract until the Contractor has obtained all insurance required under this article and such insurance has been approved by the Owner, nor shall the Contractor allow any Sub-Contractor to commence work on a subcontract until all similar insurance required of the Sub-Contractor has been so obtained and approved.

The State and the Owner does not warrant or represent that the insurance required under this paragraph constitutes an insurance portfolio which adequately addresses all risks faced by the Contractor or its Sub-Contractors. The Contractor and Sub-Contractors of every tier shall satisfy themselves as to the existence, extent and adequacy of insurance prior to commencement of work.

The Contractor and any Sub-Contractor shall procure and maintain for the duration of the Project insurance of the types and limits set forth under this paragraph and such insurance as will protect themselves from claims which may arise out of or result from the Contractor's or Sub-Contractor's execution of the work, whether such execution be by themselves or by anyone directly or indirectly employed by any of them or by anyone for whose acts any of them may be liable. The insurance coverage provided by the Contractor and any Sub-Contractor will be primary coverage. All required insurance coverages shall be placed with carriers authorized to conduct business in the State of Maine by the Maine Bureau of Insurance.

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A. Workers' Compensation Insurance

Worker's compensation insurance for all employees on site in accordance with the statutory workers' compensation law of the State of Maine.

Minimum acceptable limits for Employer's Liability are:

Bodily Injury By Accident	\$500,000
Bodily Injury by Disease	\$500,000 Each Employee
Bodily Injury by Disease	\$500,000 Policy Limit.

B. Liability Insurance

1. General Liability Insurance

General liability insurance shall be on a form providing coverage not less than that of the 1996 occurrence version of the Insurance Services Office (ISO) Commercial General Liability Policy. This insurance shall cover bodily injury and property damage liability for all hazards of the Project including premise and operations, products and completed operations, contractual, and personal injury liabilities. It shall include collapse and underground coverage - as well as explosion coverage if explosion hazards exist.

Aggregate limits shall apply on a per location or project basis.

Minimum acceptable limits are:

General aggregate limit:	\$2,000,000
Products and completed operations	\$1,000,000
Each occurrence limit:	\$1,000,000
Personal injury aggregate:	\$1,000,000

2. Automobile Liability Insurance

Automobile liability insurance against claims for bodily injury, death or property damage resulting from the maintenance, Ownership or use of all owned, nonowned and hired automobiles, trucks and trailers.

Minimum acceptable limit is \$1,000,000 any one accident or loss.

3. Owners Protective Liability

For Contracts exceeding \$50,000 in total Contract amount, Contractor shall secure an Owners Protective Liability policy naming the Owner as the Named Insured.

Minimum acceptable limits are:

General aggregate limit:	\$2,000,000
Each occurrence limit:	\$1,000,000

4. Pollution Liability

In the event that any disruption, handling, abatement, remediation, encapsulation, removal, transport, or disposal of contaminated or hazardous material is required, the

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Contractor or its Sub-Contractor shall secure a pollution liability policy in addition to any other coverages contained in this section. The insurance shall be provided on an occurrence based policy and shall remain in effect for the duration of the Project.

Minimum acceptable limit is \$1,000,000 per occurrence.

C. Property Insurance

Unless otherwise waived in writing by the Owner, the Contractor shall procure and maintain Builder's Risk insurance naming the Owner, Contractor and any Sub-Contractor as insureds as their interest may appear. Covered causes of loss form shall be all Risks of Direct Physical Loss, endorsed to include flood, earthquake, transit and sprinkler leakage where sprinkler coverage is applicable. Unless specifically authorized in writing by the Owner, the limit of insurance shall not be less than the initial contract amount and coverage shall apply during the entire contract period and until the work is accepted by the Owner.

D. Certificates of Insurance

Four original copies of all certificates of insurance in a form and issued by companies acceptable to the Owner shall be provided to the Designer prior to commencement of work. The certificates shall name the Owner as certificate holder and shall contain a provision that coverage afforded under the insurance policies will not be canceled or materially changed unless at least thirty (30) days prior written notice by registered letter has been given to the Owner.

ARTICLE 27: CONTRACT BONDS

The Contractor shall furnish to the Owner and State upon execution of the contract, a contract performance bond and a contract payment bond; each for the full amount of the contract and issued by a surety company or surety companies authorized to do business in the State of Maine as approved by the Owner and State. The bonds shall be in accordance with and executed on the forms furnished in the specifications. The bonds shall allow for any addition or deductions to the contract.

The contract bonds shall continue in effect for the applicable periods limiting actions as provided by, as applicable, 14 MRSA Section 871 or Section 752 to protect the Owner's interest and to assure settlement of claims for the payment of all bills for labor, materials, and equipment by the Contractor.

The Contractor shall submit to the Bureau of General Services through the Designer, copies of the Contract Performance Bond and Contract Payment Bond for each of the Filed Sub-Bid Subcontractors that were required to submit Bid Bonds.

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ARTICLE 28: DAMAGES

1. The Contractor shall indemnify and hold harmless the Owner and the Designer and their agents and employees from and against all claims, damages, losses, and expenses including attorneys' fees arising out of or resulting from the performance of the work, provided that any such claim, damage, loss, or expense (a) is attributable to bodily injury sickness, disease or death, or injury to or destruction to tangible property (other than the work itself) including the loss of use resulting therefrom, and (b) is caused in whole or in part by a negligent act or omission of the Contractor, any Sub-Contractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, regardless of whether or not it is caused in part by a party indemnified hereunder.

2. In any and all claims against the Owner or the Designer or any of their agents or employees, by any employee of the Contractor, any Sub-Contractor, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, the indemnification obligation under paragraph 1 shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for the Contractor or any Sub-Contractor under Workmen's Compensation Acts, disability benefit acts, or other employee benefit acts.

3. The obligations of the Contractor under paragraph 1 shall not exceed the liability of the Designer, the Designer's agents or employees arising out of:

- (a) The preparation or approval of maps, drawings, opinions, reports, surveys, change orders, designs or specifications; or
- (b) The giving of or the failure to give directions or instructions by the Designer, the Contractor, agents or employees provided such giving or failure to give is the primary cause of the injury or damage.

ARTICLE 29: LIENS

Neither the final payment nor any part of the retained percentage shall become due until the Contractor, shall deliver to the Owner a complete release of all liens arising out of this contract, or receipts in full in lieu thereof, and, an affidavit that so far as the Contractor has knowledge or information the releases and receipts include all the labor and material for which a lien could be filed; but the Contractor, may if any Sub- Contractor refuses to furnish a release or receipt in full, furnish a bond satisfactory to the Owner, to indemnify him against any lien. If any lien remains unsatisfied after all the payments are made, the Contractor shall refund to the Owner all moneys that the latter may be compelled to pay in discharging such lien, including all cost and reasonable attorney's fee.

ARTICLE 30: ASSIGNMENT

Neither party to the contract shall assign the Contractor or sublet it as a whole without the written consent of the other, nor shall the Contractor assign any money due or to become due to him hereunder, without the previous written consent of the Owner.

ARTICLE 31: MUTUAL RESPONSIBILITY OF CONTRACTORS

Should the Contractor cause damage to any separate Contractor on the work, the Contractor agrees, upon due notice, to settle with such Contractor by agreement or arbitration, if he will so settle. If such separate Contractor sues the Owner or Designer on account of any damage alleged to have been so sustained, the Owner or Designer shall notify the Contractor, who shall defend such proceedings at the Contractor's expense and if any judgment against the Owner or Designer arises therefrom, the Contractor shall pay or satisfy it and pay all costs incurred by the Owner or Designer.

ARTICLE 32: SEPARATE CONTRACTS

The Owner reserves the right to let other contracts in connection with this work under similar general conditions. The Contractor shall afford other Contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work, and shall properly connect and coordinate his work with theirs.

If any part of the Contractor's work depends on proper execution or results upon the work of any other Contractor, the Contractor shall inspect and promptly report to the Designer any defects in such work that render it unsuitable for such proper execution and results. The Contractor's failure so to inspect and report shall constitute an acceptance of the other Contractor's work as fit and proper for the reception of his work, except as to defects which may develop in Contractor's work after the execution of the Contractor's work.

To insure the proper execution of the Contractor's subsequent work the Contractor shall measure work already in place and shall at once report to the Designer any discrepancy between the executed work and the drawings.

ARTICLE 33: SUBCONTRACTS

The Contractor shall not sublet any part of this contract without the written permission of the Owner.

The Contractor shall submit in writing to the Designer for approval a complete list of the names of all particular items of work he proposes to furnish and the names of the Sub-Contractors to whom the Contractor proposes to sublet work. The Sub-Contractors named shall be reputable firms of recognized standings with a record of satisfactory work. The Contractor shall not employ any Sub-Contractor or use any material that requires approval by any Specification Section until they have been approved, or where there is reason to believe the work will not be accomplished in accordance with the contract documents. The complete list of Sub-Contractors and materials must be submitted for approval to the Designer and

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Owner.

The Designer shall, on request, furnish to any Sub-Contractor, wherever practicable, evidence of the amounts certified on his account.

The Contractor agrees that he is as fully responsible to the Owner for the acts and omissions of his Sub-Contractor and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by him.

Nothing contained in the contract documents shall create any contractual relation between any Sub-Contractor and the Owner.

ARTICLE 34: RELATIONS OF CONTRACTOR AND SUB-CONTRACTOR

The Contractor agrees to bind every Sub-Contractor and every Sub-Contractor agrees to be bound by the terms of the contract documents, as far as they are applicable to his work, including the following provisions of this article, unless specifically noted to the contrary in a subcontract approved in writing as adequate by the Owner or Designer.

The Sub-Contractor agrees:

- A. To be bound to the Contractor by the terms of the contract documents, and to assume toward the Contractor all the obligations and responsibilities that the Contractor, by those documents, assumes toward the Owner.
- B. To submit to the Contractor applications for payment in such reasonable time as to enable the Contractor to apply for payment as specified.
- C. To make all claims for extras, for extensions of time and for damages for delays or otherwise, to the Contractor in the manner provided in the general conditions for like claims by the Contractor upon the Owner, except that the time for making claims for extra cost is one week.

The Contractor agrees:

- D. To be bound to the Sub-Contractor by all the obligations that the Owner assumes to the Contractor under the contract documents, and by all the provisions thereof affirming remedies and redress to the Contractor from the Owner.
- E. To pay the Sub-Contractor, upon the payment of certificates, the amount allowed to the Contractor on account of the Sub-Contractor's work to the extent of the Sub-Contractor's interest therein.
- F. To pay the Sub-Contractor, upon the payment of certificates, if issued otherwise as in section E above, so that at all times the Sub-Contractor's total payments shall be as large in proportion to the value of the work done by the Sub-

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Contractor.

G. To pay the Sub-Contractor to such extent as may be provided by the contract Documents or the subcontract, if either of these provide for earlier or larger payments than the above.

H. To pay the Sub-Contractor on demand for subcontract work or materials as far as executed and fixed in place, less the retained percentage, at the time the certificate should issue, even though the Designer fails to issue it for any cause not the fault of the Sub-Contractor.

I. To make no demand for liquidated damages or penalty for delay in any sum in excess of such amount as may be specifically named in the subcontract.

J. That no claim for services rendered or materials furnished by the Contractor to the Sub-Contractor shall be valid unless written notice thereof is given by the Contractor to the Sub-Contractor during the first ten days of the calendar month following that in which the claim originated.

K. To give the Sub-Contractor an opportunity to present and to submit evidence in any progress conference or disputes involving subcontract work.

L. To pay the Sub-Contractor a just share of any fire insurance money received by him, the Contractor, under Article 26 of the General Conditions.

ARTICLE 35: DESIGNER'S STATUS

The Designer shall be the Owner's representative during the construction period and he shall observe the work in progress on behalf of the Owner. He shall have authority to act on behalf of the Owner only to the extent expressly provided in the contract documents or otherwise in writing, which shall be shown to the Contractor. He shall have authority to stop the work whenever such stoppage may be necessary in his reasonable opinion to insure the proper execution of the contract.

The Designer shall be, in the first instance, the interpreter of the conditions of the contract and the judge of its performance. The Designer shall side neither with the Owner nor with the Contractor, but shall use the Designer's powers under the contract to enforce its faithful performance by both.

In case of the termination of the employment of the Designer, the Owner shall appoint a capable and reputable Designer whose status under the contract shall be that of the former Designer.

ARTICLE 36: CASH ALLOWANCES

The Contractor shall include the contract sum and all allowances named in the contract documents and shall cause the work so covered to be done by such Contractors and for such

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sums as the Designer may direct, the contract amount being adjusted in conformity therewith. The Contractor declares that the contract amount includes such sums for expenses and profit on account of cash allowances, as he deems proper. No demand for expenses or profit other than those included in the contract shall be allowed. The Contractor shall not be required to employ for any such work, persons against whom the Contractor has a reasonable objection.

ARTICLE 37: USES OF PREMISES

The Contractor shall confine his apparatus; the storage of materials and the operations of his workmen to limits indicated by law, ordinances, permits or directions of the Designer, and as required by the Contract Documents, and shall not unreasonably encumber the premises with his materials.

The Contractor shall not load or permit any part of the structure to be loaded with a weight which will endanger its safety. The Contractor shall enforce the Designer's instructions regarding signs, advertisements, fires, and smoking.

If any part of the building is completed and ready for occupancy, the Owner may, by written and mutual consent, without prejudice to any of the Owner's rights or the rights of the Contractor enter in and make use of such completed parts of the building. Such use or occupancy shall in no case be construed as an acceptance of any work or materials.

ARTICLE 38: CUTTING, PATCHING AND DIGGING

The Contractor shall do all cutting, fitting or patching of his work that may be required to make its several parts come together properly and fit it to receive or be received by work of other Contractors shown upon, or reasonable implied by, the drawings and specifications for the completed structure, and he shall make good after them as the Designer may direct.

Any cost caused by defective or ill-timed work shall be borne by the party responsible therefore. The Contractor shall not endanger any work by cutting, excavating or otherwise, and shall not cut or alter the work of any other Contractor save with the consent of the Designer. Cutting, drilling, or patching work of Contractors other than the general Contractor shall be done only with the permission and instruction of the general Contractor and Designer. Cutting of structural members must be approved by the Designer. All cutting, patching, and digging of other Contractors in or about the building shall be done under the supervision of the general Contractor who shall be responsible to see that the work is neatly done, and in a manner that will not endanger the structure or harm the component parts, and that patching and back filling shall be done to restore the structure and surfaces to its original condition.

ARTICLE 39: LAYOUT OF WORK

The Contractor shall be responsible for the correct staking out of the new work on the site, and shall employ a competent engineer/surveyor to locate the building on the site. He shall run the axis lines locating the work, establish correct datum points, and check each line

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and point on the site to insure their correctness. All such lines and points shall be carefully preserved throughout the construction.

The Contractor shall lay out all work from dimensions given on plans. The Contractor shall take measurements and verify dimensions of existing or old work, if any, that affect his work or to which his work is to be fitted. The Contractor alone shall be responsible for the correctness of all measurements and shall verify all grades, lines, levels, elevations and dimensions shown on the drawings and report any errors or inconsistencies to the Designer prior to commencing work.

ARTICLE 40: WORKMANSHIP

All workmanship, materials or equipment, either at the site or intended for it shall conform with all respects with the requirements of all the contract documents, and shall be strictly first class, workmanlike installation and the best obtainable from the crafts and trades. Incomplete or careless workmanship will not be allowed. In all cases the materials, equipment and work shall be equal to or better than the grade specified and the best of their kind that is obtainable for the purpose for which they are intended. The Designer's decision on the quality of work shall be final.

All labor shall be performed by mechanics skilled in their respective trades. Prior to submitting a proposal, the Contractor shall become familiar with the local labor conditions, skilled and unskilled.

If, in the opinion of the Contractor, any work is indicated on the drawings or specified in such manner as would make it impossible to produce work of the highest quality, or should discrepancies appear between drawings, or drawings and specifications, the Contractor shall refer the same in writing to the Designer for interpretation before proceeding with the work.

If the Contractor fails to make such reference, no excuse will be entertained thereafter for failure to carry out the work in the satisfactory manner.

The Contractor shall guarantee the Contractor's work against any defects in workmanship and materials for a period of one year from the date of the written final acceptance of the project.

ARTICLE 41: CLEANING UP

The Contractor shall at all times keep the premises free from accumulation of waste materials or rubbish caused by his employees or work, and at the completion of the work he shall remove all his rubbish from and about the building and all his tools, scaffolding and surplus materials and shall leave his work "Broom Clean" or its equivalent, unless more exactly specified.

In case of failure to comply by the Contractor, the Owner may perform the cleanup and deduct the cost from any monies due the Contractor.

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ARTICLE 42: DISPUTE RESOLUTION

If, in the performance of this contract, there arises a dispute between the Contractor and the Owner that cannot be resolved by the parties to the contract, the dispute shall be referred to the Director of the Bureau of General Services who, at his/her discretion, will submit the dispute to non-binding Alternate Dispute Resolution (ADR) or binding arbitration. If the parties in dispute are not satisfied with the results of ADR the Owner or the Contractor may resubmit the dispute to the Director of the Bureau of General Services for binding arbitration.

In any non-binding Alternative Dispute Resolution (ADR) or binding arbitration between the Owner and the Contractor, the Owner may elect to consolidate related claims between the Owner and the Designer. Any mediator and/or arbitrator shall be subject to the mutual approval of the Owner, the Contractor and, as applicable, the Designer, such approval not to be unreasonably withheld by any party.

ARTICLE 43: COMPLETION TIME AND LIQUIDATED DAMAGES

a) The Date(s) of Completion is stated in the Proposal Form Section 2-B and in the Contract Form Section 2-E. If the Contractor finds it impossible to complete the Work on or before the said Date(s) of Completion, he make a written request to the Owner for an Extension of Time setting forth therein the reasons for the request. If the Owner finds that the Work was delayed because of conditions beyond the control and without the fault of the Contractor he may extend the Date(s) of Completion which will then be in full force and effect, the same as though it was the original Date(s) of Completion. b) Time is an essential element of the Contract and it is important the Work be pressed vigorously to Completion. The cost to the Owner of Administration of the Contract, inspection and supervision will be increased as the time occupied in the Work, is lengthened. c) For each calendar day that the Work shall remain uncompleted after the Date(s) of Completion specified in the Contract, the amount per day, listed below in the Schedule of Liquidated damages, shall be deducted from any money due the Contractor, not as a penalty but as liquidated damages, provided, however that due account shall be taken of any adjustment of the Date(s) of Completion granted under the provisions of Paragraph (a) above. d) The Contractor shall expressly be prohibited from filing delay claims or attempting to recover damages for its scheduled early completion. The Owner and Designer have not requested accelerated schedules and cannot accommodate the Contractor if he chooses to accelerate the Work. The Owner and Designer have designed the Project to be done in an orderly fashion which allows for bad weather, minor changes in the Work, and an orderly submittal and review process of materials and workmanship. Any Contractor choosing to bid the project with accelerated completions, earlier than those allowed by the phasing plan, has a duty to inform the project owner of the Contractor's intention to achieve early completion and he shall also note early completion as a qualification on his bid form. The Owner reserves the right to reject all bids containing limitations or qualifications.

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SCHEDULE OF LIQUIDATED DAMAGES

<u>Damages</u>	<u>Amount of Liquidated Per Day</u>
<u>Original Contract Amount</u>	
More than \$ 100,000 and less than \$ 3,000,000	\$ 750.00
More than \$ 3,000,000 and less than \$ 7,000,000	\$ 1000.00
More than \$ 7,000,000 and less than \$ 10,000,000	\$ 1500.00
More than \$ 10,000,000	\$ 1500.00 plus \$ 150 per \$ 1,000,000

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3-B - SUPPLEMENTARY CONDITIONS

These Supplementary Conditions supplement and, as applicable, amend The State of Maine Standard General Conditions and Contract Work for Public School Projects (the "General Conditions").

1. The parties recognize that the Project is locally funded, and that the role of the Bureau of General Services for locally funded projects is primarily advisory. Accordingly, notwithstanding anything to the contrary in the contract documents, submission to or review or approval by the Bureau of General Services shall not be required, except to the extent such submission, review or approval is required by state law or regulation for locally funded school construction projects. Furthermore, wherever used in the contract documents, "Bureau" and "Bureau of General Services" shall mean the Owner, unless the specific provision of the contract documents is in fulfillment of a state law or regulation that must be complied with in the case of a locally funded school construction project.
2. Revise the sixth paragraph of ARTICLE 9 to read "The Contractor warrants and guarantees his work against any defects in workmanship and materials for a period of one year from the date of the written acceptance of the project.
3. Revise last sentence in the first paragraph of Article 19 to read "Inclement weather or other natural causes shall not be reason to allow additional time under this contract, with the exception of tornado, earthquake, flood, or similar event that causes catastrophic damage and delay."
4. The release of liens required by Article 24, Payments, of the General Conditions shall be in the form of Exhibit A and Exhibit B to these Supplementary Conditions. Final lien waiver and accompanying affidavit required by Article 29, Liens, shall be substantially in the form of AIA Documents G706 and G706A and shall be accompanied by final releases of lien for each subcontractor and supplier as specified therein. Final releases for each Phase shall be submitted by the Contractor upon final completion of each of Phase 1 and of Phase 2, respectively.
5. ARTICLE 26: CONTRACTOR'S INSURANCE REQUIREMENTS, Paragraphs A, B, C and D are deleted in their entirety and replaced with the following:

A. Workers' Compensation Insurance

Worker's compensation insurance for all employees on site in accordance with the statutory workers' compensation law of the State of Maine. (Provide Owner as Additional Insured and Waiver of Subrogation endorsements if available from the insurance carrier)

Minimum acceptable limits for Employer's Liability are:

Bodily Injury By Accident	\$500,000
Bodily Injury by Disease	\$500,000 Each Employee
Bodily Injury by Disease	\$500,000 Policy Limit.

B. Liability Insurance

1. General Liability Insurance

General liability insurance shall be on a form providing coverage not less than that of the Insurance Services Office (ISO) Commercial General Liability Policy, CG 00 01 12 04, Endorsements: CG 2010 – Additional Insured (naming the City and School Dept.), CG2503-General Aggregate Per Project, and CG2404 (if not included in form) Waiver of Transfer of Rights of recovery. This insurance shall cover bodily injury and property damage liability for all hazards of the Project including premise and operations, products and completed operations, contractual, and personal injury liabilities. It shall include collapse and underground coverage as well as explosion coverage if explosion hazards exist. Aggregate limits shall apply on a per location or project basis.

Minimum acceptable limits are:

General aggregate limit:	\$2,000,000
Products and completed operations aggregate:	\$1,000,000
Each occurrence limit:	\$1,000,000
Personal injury aggregate:	\$1,000,000

2. Automobile Liability Insurance

Automobile liability insurance against claims for bodily injury, death or property damage resulting from the maintenance, Ownership or use of all owned, nonowned and hired automobiles, trucks and trailers.

Minimum acceptable limit is \$1,000,000 any one accident or loss.

3. Owners Protective Liability

For Contracts exceeding \$50,000 in total Contract amount, Contractor shall secure an Owners Protective Liability policy naming the Owner as the Named Insured.

Minimum acceptable limits are:

General aggregate limit:	\$2,000,000
Each occurrence limit:	\$1,000,000

4. Pollution Liability

In the event that any disruption, handling, abatement, remediation, encapsulation, removal, transport, or disposal of contaminated or hazardous material is required, the Contractor or its Sub-Contractor shall secure a pollution liability policy in addition to any other coverages contained in this section. The insurance shall be provided on an occurrence based policy and shall remain in effect for the duration of the Project. If not available and a claims made policy is provided, include an extended reporting period of three years after project completion.

Minimum acceptable limit is \$1,000,000 per occurrence.

5. Commercial Umbrella/Excess Liability Insurance: \$10,000,000

C. Property Insurance

The Owner will provide the Builder's Risk insurance.

D. Certificates of Insurance

Four original copies of all certificates of insurance in a form and issued by companies acceptable to the Owner shall be provided to the Designer prior to commencement of work. The Owner shall be listed on the certificates as an additional insured, and certificate shall include Waiver of Subrogation in favor of the Owner. The certificates shall name the Owner as certificate holder and shall contain a provision that coverage afforded under the insurance policies will not be canceled or materially changed unless at least thirty (30) days prior written notice by registered letter has been given to the Owner. Cancellation Notice of 30 days shall be specifically endorsed to the policies."

7. ARTICLE 42: DISPUTE RESOLUTION, is deleted in its entirety and replaced with the following:

"ARTICLE 42: DISPUTE RESOLUTION

If, in the performance of this contract, there arises a dispute between the Contractor and the Owner that cannot be resolved by the parties to the contract, the parties shall submit the dispute to

a single mediator selected by parties. The parties agree to mediate the dispute in good faith for not more than one day at a date, time and place in Cumberland County, Maine specified by the mediator. The parties shall equally share the costs and fees of the mediator, but shall otherwise bear their own costs of mediation. If the parties are unable to agree upon a mediator or otherwise fail to resolve their differences through mediation, then either party may demand arbitration pursuant to the Maine Uniform Arbitration Act, 14, M.R.S.A. §5927-5949. There shall be one arbitrator selected by the parties. If the parties cannot agree upon an arbitrator within thirty (30) days of a demand for arbitration, then either party may apply to Maine Superior Court for selection of an arbitrator. The arbitrator selected shall conduct the arbitration proceeding. All issues which relate to the controversy or dispute shall be resolved in the arbitration, which shall be final and binding provided that in any arbitration the arbitrator shall be bound by and follow the substantive laws of Maine. The arbitration hearing shall be conducted in Maine and shall not exceed two days unless agreed by the parties or ordered by the arbitrator. The parties shall equally share the costs and fees of the arbitrator, but shall otherwise bear their own costs of arbitration except that if the arbitrator determines that either party has acted unreasonably or in bad faith, the arbitrator may require that party to reimburse the other party for its reasonable costs, including but not limited to arbitration costs and reasonable attorney's fees.

In any binding arbitration between the Owner and the Contractor, the Owner may elect to consolidate related claims between the Owner and the Designer, in which case the selection of the arbitrator shall also be subject to approval of the Designer.”

8. **ARTICLE 43: COMPLETION TIME AND LIQUIDATED DAMAGES**

The Owner shall be entitled to actual damages if Owner's actual damages exceed the liquidated damages provided by Article 43 of the General Conditions.

SECTION 3 - B

**EXHIBIT A
PARTIAL LIEN WAIVER**

The undersigned, _____ as Contractor under a Contract by and between the undersigned and the York School Department (“Owner”), has furnished or caused to be furnished labor or materials, or both, for the premises owned by Owner and located on or about York Middle School Window Replacement Project, York, ME (“Premises”); and

The undersigned hereby certifies to the Owner that through the date set forth below, the sum of \$ _____ is now due and payable to the undersigned, with retainage due but not yet payable, in the amount of \$ _____ and with a balance of \$ _____ due upon completion (or as it becomes due) of the Contract by and between the undersigned and Owner, and

The undersigned certifies to the Owner that all subcontractors or suppliers of labor, services, material or equipment used, engaged or employed by the undersigned directly or indirectly, have been paid in full, or shall immediately be paid in full from the payment requisition submitted to Owner herewith, with respect to the labor materials furnished to the Premises through the date set forth below; and

The undersigned further certifies that the attached hereto are partial Lien Waivers obtained by the undersigned from all subcontractors or suppliers for whose work or materials partial payment is to be made from the payment requisition submitted herewith or who are otherwise entitled to payment and the undersigned hereby agrees to indemnify and hold Owner harmless from any and all claims by any party whatsoever in connection with the labor or materials furnished, caused to be furnished or intended to be furnished by or on behalf of the undersigned through the date set forth below; and

The undersigned does hereby acknowledge full performance by the Owner of all obligations due or owing to the undersigned in connection with the Premises and the project through the date set forth below; does hereby release the Owner of all claims, demands and actions arising out or in connection with the Premises and project through the date set forth below; and does hereby waive and release any lien or right to lien the Premises, including any building improvements, on account of any and all labor or materials, or both furnished for or incorporated into the Premises through the date set forth below.

Dated

Dated

Witness

Contractor

State of Maine
County of _____

Then personally appeared before me the above-named Contractor and acknowledged the foregoing to be a free act and deed.

Notary Public

Dated

Print Name

Note: This Partial Lien Waiver and all attached Partial Lien Waivers from subcontractors and suppliers must be dated not more than ten (10) days before Contractor’s payment requisition.

SECTION 3 - B

**EXHIBIT B
PARTIAL LIEN WAIVER
(Subcontractor and Suppliers)**

The undersigned, _____ pursuant to a Contract or Agreement with _____ (“Contractor”), has furnished or caused to be furnished labor or materials, or both, for the premises owned by the York School Department and located on or about the York High School Family Sciences Classroom Renovation Project, York, ME (“Premises”); and

The undersigned hereby certifies to the Owner that through the date set forth below, the sum of \$ _____ is now due and payable to the undersigned, with retainage due but not yet payable, in the amount of \$ _____ and with a balance of \$ _____ due upon completion (or as it becomes due) of the Contract or Agreement with the Contractor; and upon receipt of the sums now due the undersigned shall and does hereby release the Contractor from all claims, demands and actions on account of labor or materials to or for the Premises through the date set forth below; and

The undersigned certifies to the Owner that all Contractor that all subcontractors or suppliers of labor, services, material or equipment used, engaged or employed by the undersigned directly or indirectly, have been paid in full, or otherwise satisfied with respect to labor or materials furnished to the Premises through the date set forth below; and the undersigned hereby agrees to indemnify and hold the Owner and Contractor harmless from any and all claims by any party whatsoever in connection with the labor or materials furnished by the undersigned; and

The undersigned does hereby acknowledge full performance by the Owner of all obligations due or owing to the undersigned in connection with the Premises and the project through the date set forth below; does hereby release the Owner of all claims, demands and actions arising out or in connection with the Premises and project through the date set forth below; and does hereby waive and release any lien or right to lien the Premises, including any building improvements, on account of any and all labor or materials, or both furnished for or incorporated into the Premises through the date set forth below.

Dated

Dated

Witness

Subcontractor / Supplier

By: Its

Note: This Partial Lien Waiver and all attached Partial Lien Waivers from subcontractors and suppliers must be dated not more than ten (10) days before Contractor’s payment requisition.

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Work covered by the Contract Documents.
 - 2. Type of the Contract.
 - 3. Work schedule.
 - 4. Work under other contracts.
 - 5. Owner-furnished products.
 - 6. Owner's occupancy requirements.
 - 7. Specification formats and conventions.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: York High School Family Sciences Classroom Renovation.
 - 1. Project Location: York, Maine.
- B. Owner: York School District.
- C. Architect: Harriman, Auburn Business Park, 46 Harriman Drive, Auburn, ME 04210.

1.4 TYPE OF CONTRACT

- A. Project will be constructed under a single prime contract.

1.5 WORK SCHEDULE

- A. Schedule:
 - 1. Work may begin on May 25, 2024 and all work shall be substantially complete on or before August 19, 2024.
- B. Do not disturb adjacent spaces during hours of operation.
- C. Time: The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

1.6 OWNER-FURNISHED PRODUCTS

- A. Owner will furnish products indicated and/or as specified. The Work includes providing support systems to receive Owner's equipment.
 - 1. Contractor is responsible for protecting Owner-furnished items from damage during storage and handling, including damage from exposure to the elements.
 - 2. Contractor shall install and otherwise incorporate Owner-furnished items into the Work.

1.7 OWNER'S OCCUPANCY REQUIREMENTS

- A. Full Owner Occupancy: Owner will occupy site and premises during entire construction period with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits, unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 - 2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.8 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the CSI/CSC's "MasterFormat" numbering system.
 - 1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
 - 2. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.

- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 - 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

1.9 MISCELLANEOUS PROVISIONS

- A. Material safety data sheets shall be made available in accordance with OSHA requirements.
- B. No asbestos containing materials shall be used in the work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

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SECTION 013300 - SUBMITTAL PROCEDURES (2023)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. 013100 "Project Management and Coordination" for submitting and distributing meeting and conference minutes and for submitting Coordination Drawings.
 - 3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 4. Section 014000 "Quality Requirements" for submitting test and inspection reports and for mockup requirements.
 - 5. Section 017700 "Closeout Procedures" for submitting warranties.
 - 6. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 7. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 8. Section 017900 "Demonstration and Training" for submitting documentation of demonstration of equipment and training of Owner's personnel.
 - 9. Division 01 to 33 Sections for specific requirements for submittals in those Sections.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Electronic Document Files: Copies of the Contract Drawings in electronic format will be made available by the Architect to those requesting same in accordance with the "Agreement Between Harriman (Architect & Engineer of Record) and Owner or Contractor for Release of Electronic Documents" form attached to the end of this section. Agreement form shall be filled out and signed by each party requesting electronic documents before electronic media is released to them.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each specification section concurrently.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
 5. No products shall be incorporated into the work unless they have been approved by the Contractor and Architect. No work will be paid for until required submittals for applicable work have been submitted and approved.
- C. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 14 calendar days minimum for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 14 calendar days minimum for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 calendar days minimum for initial review of each submittal.
- E. Electronic Submittals: **Architect is using Newforma software to process electronic submittals.** Submittals must be sent for review individually (one submittal per email). Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into single files incorporating submittal requirements of a single specification section and transmittal form.
 - a. Provide a separate transmittal form for Product Data, a separate transmittal form for Shop Drawings, and a separate transmittal form for Informational Submittals required by each Specification Section.

- b. Maximum File Size: A single file size, up to 18 MB can be received. Contact Architect for instructions if file exceeds 18 MB.
 - c. For each transmittal, attach one single PDF only. Where multiple PDFs are required for a transmittal, utilize a combine feature to merge the PDFs into a single PDF.
 - 1) Unacceptable Formats: In order to process the transmittals in Newforma, the single PDF file protocol must be followed. Transmittals zip files or grouped PDFs cannot be electronically processed and will be returned without action for correction and resubmittal.
 - 2) Submittals will be returned without action for correction and resubmittal if:
 - a) Submittal does not have an electronic Transmittal Form.
 - b) Multiple specification sections are contained within a single Transmittal form. Submittals must be separated into individual Specification Sections.
 - c) Submittal does not include the Contractors' signed reviewed stamp
 - 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a dash and then a sequential number (e.g., LNHS-061000-01). Resubmittals shall include an alphabetic suffix after another dash (e.g., LNHS-061000-01-A).
 - 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 - 4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Names of subcontractor, manufacturer, and supplier.
 - g. Submittal number or other unique identifier, including revision identifier.
 - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
 - h. Specification Section number and title.
 - i. Drawing number and detail references, as appropriate.
 - j. Location(s) where product is to be installed, as appropriate.
 - k. Related physical samples submitted directly.
 - l. Indication of full or partial submittal.
 - m. Other necessary identification.
- F. Options: Identify options requiring selection by Architect.
- G. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- 1. Note date and content of previous submittal.

2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with appropriate notation from Architect's action stamp.
- I. Architect will return all processed submittals through the Newforma file transfer procedure. Contractor will be responsible for incorporating the processed submittals into their file management systems as appropriate.
 - J. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
 - K. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with appropriate notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 1. Submit electronic submittals by either of the following methods:
 - a. Via email as PDF electronic file to constructadmin@harriman.com .
 - 1) Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 - b. Post electronic submittals as PDF electronic files directly to Architect's FTP site specifically established for Project.
 - 1) Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:

- a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file.
 7. Do not submit Material Safety Data Sheets (MSDSs).
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Schedules.
 - d. Compliance with specified standards.
 - e. Notation of coordination requirements.
 - f. Notation of dimensions established by field measurement.
 - g. Relationship and attachment to adjoining construction clearly indicated.
 - h. Seal and signature of professional engineer if specified.
 2. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

- a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
- 6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit two sets of Samples. Architect will retain one Sample sets; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 - 2. Manufacturer and product name, and model number if applicable.
 - 3. Number and name of room or space.
 - 4. Location within room or space.
 - 5. Submit product schedule in the following format:
 - a. PDF electronic file.
- F. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
- K. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

- L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- N. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- O. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- R. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- S. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- T. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before

installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

- W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- Y. Material Safety Data Sheets (MSDSs): Submit information directly to Owner at end of the project; do not submit to Architect. Maintain copy at the site for the duration of the construction.
 - 1. Architect will not review submittals that include MSDSs and will return them.

2.2 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Contractor to mark submittal with their approval stamp before submitting to Architect.
 - 1. The Contractor shall review submittals for completeness and compliance with the Contract Documents. If submittal contains substitutions, Contractor shall process substitutions in accordance with Division 01 Section "Substitutions and Product Options," and not part of specified Shop Drawings or Product Data submittals. Contractor is responsible for keeping Subcontractors on time with the submittal schedule. If the Contractor submits submittals that are repeatedly rejected, requiring the Architect to perform multiple reviews of the same submittal because of the failure to properly prepare and complete the submittals:
 - a. Owner will compensate Architect for such additional services.
 - b. Owner will deduct the amount of such compensation from the final payment to the Contractor.

- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. General: Architect will not review submittals that do not bear Contractor's submittal stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an appropriate mark to indicate status.
 - 1. The Architect's marking of "Reviewed, Furnish as Corrected or similar verbiage means submittal has been reviewed for general conformance to the contract documents only and does not mean unqualified acceptance. The Contractor is fully responsible for compliance with the contract documents.
- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- E. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- F. Submittals not required by the Contract Documents will be returned by the Architect without action.

END OF SECTION 013300

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**AGREEMENT BETWEEN HARRIMAN (ARCHITECT & ENGINEER OF RECORD)
AND OWNER OR CONTRACTOR
FOR RELEASE OF ELECTRONIC DOCUMENTS**

RECIPIENT:

Name: _____ Phone Number: _____

Address: _____

Email Address: _____ Date: _____

Project Name: _____ HA Project No.: _____

- This request to for Harriman to provide the following Electronic Documents (AutoCad file or Revit model), dated _____, for the project use by the Recipient:

(List requested documents clearly) _____

-
- Electronic Documents will be provided in the current software version used by Harriman at the time of the request. Alternate versions may be available at Harriman’s discretion. Current software versions are AutoCAD 2023 and Autodesk Revit 2023.

Alternate Version Requested: _____

- Transfer method shall be by Electronic File Transfer to the email address provided above.
- A fee may be assessed for processing and distributing requested document. Recipient will be notified on any fees prior after receipt of this request document. Fees are payable prior to receiving requested documents.

TERMS AND CONDITIONS:

1. For the purpose of this document, both 2d CAD files and 3d Revit models shall be collectively defined as “Electronic Documents”.
2. It is understood and agreed that all drawings, specifications, or other documents of any kind prepared by Harriman or its subconsultants, whether in hard copy or in electronic format including Electronic Documents (collectively "Harriman’s Documents"), are instruments of their services prepared solely for use in connection with the single project for which they were prepared and that Harriman and its subconsultants retain all common law, statutory and other reserved rights, including the copyright. This agreement is not intended in any way to alter the respective interests of the parties in the Instruments of Service as set forth in the Owner/Architect Agreement, notwithstanding Harriman’s agreement to release the Electronic Documents to Recipient.
3. The Electronic Documents are provided as a convenience to the Recipient for informational purposes only in connection with the Recipient’s performance of its responsibilities and obligations relating to the Project. The Electronic Documents do not replace or supplement the paper copies of the Drawings and Specifications, which are, and remain, the Contract Documents for the Project. In all instances, it is the responsibility of the Recipient to ensure that the Electronic Documents are

consistent with the Contract Documents.

4. The parties agree that the Electronic Documents are not, nor shall they be construed to be, a product. It is expressly agreed by the Recipient that there are no warranties of any kind in such Electronic Documents or in the media in which they are contained, either expressed or implied.
5. Harriman makes no representation as to the compatibility of the Electronic Documents with any hardware or software.
6. Since the information set forth on the Electronic Documents can be modified unintentionally or otherwise, Harriman reserves the right to remove all indicia of its ownership and/or involvement from each electronic display.
7. If any differences exist between printed Instruments of Service and Electronic Documents, the information contained in the printed documents shall be presumed to be correct and take precedence over the Electronic Documents.
8. Recipient agrees not to add to, modify or alter in any way, or to allow others to add to, modify or alter in any way, the Electronic Documents or any printed copies thereof.
9. Revit models are Design Models and will only contain elements and content that Harriman deems necessary and appropriate to share. Not all objects in the models are 3d objects and no specific Level of Detail is implied or expected. Consequently, the models cannot be used to extract precise material or object quantities. The Recipient agrees that no proprietary Revit families or Revit content shall be removed from the model and/or used for any other purpose but to support this specific project.
10. The Electronic Documents are supplied in a translatable format. Any conversion of the format is solely the responsibility of the Recipient. Recipient understands and agrees that the conversion of hard copies of Instruments of Service into electronic format or the conversion of Electronic Documents from formats used by Harriman to some other format may introduce errors or other inaccuracies. Recipient agrees to accept all responsibility for any errors or inaccuracies and to release Harriman, and its subconsultants from any liability or claims for recovery of damages or expenses arising as the result of such errors or inaccuracies.
11. Where the Recipient has received specific permission to use the Electronic Documents in connection with the Recipient's obligation to prepare certain documents for Project, Recipient shall, in addition to the other obligations set forth therein, be obligated to remove Harriman's or its Consultant's title block from the copy of the Electronic Documents used by Recipient. It is understood and agreed that, without the separate express written permission of Harriman to do so, the Electronic Documents are not to be used by any contractor or any of its subcontractors of any tier of material supplier or vendor as a shop drawing or any other type of submittal or as the basis for preparing such shop drawing or submittal. The sole exception to this prohibition shall be that the Recipient may use the Electronic Documents as a clearly distinguishable separate background upon which to prepare its shop drawings or other submittal.
12. Recipient further agrees that Harriman's Documents were prepared for use in connection with this project only and that the Electronic Documents are supplied to Recipient for the limited use stated above only. Recipient agrees not to use, or to allow others to use, the Electronic Documents, in whole or in part, for any purpose other than as stated above.

13. Harriman believes that no licensing or copyright fees are due to others on account of the transfer of the Electronic Documents, but to the extent any are, the Contractor will pay the appropriate fees and hold Harriman harmless from such claims.
14. Any purchase order number provided by the Contractor is for Contractor's accounting purposes only. Purchase order terms and conditions are void and are not a part of this agreement.
15. Harriman has prepared these Electronic Documents for the sole purpose of plotting and printing a hard copy of the design documents. Harriman believes only the hard copy print to be the accurate representation of all drawing information. Hard copy written dimensions override electronic measured dimensions. User must verify computer data against hard copy prints.
16. Electronic Documents are an inherently unstable medium subject to "bugs," deterioration, modifications, and viruses. Electronic Documents are subject to inadvertent changes in the process of moving from one computer to another or by compressing/decompressing the data; or by moving from one software revision to another; or any kind of manipulation of the data will lead to defects.
17. This agreement shall be governed by the laws of the principal place of business of Harriman. Only printed copies of the Instrument of Service shall be signed and sealed.
18. Recipient agrees to waive any and all claims and liability against Harriman and its subconsultants resulting in any way from any failure by Recipient to comply with the requirements of this Agreement for the Delivery of Documents in Electronic Format.
19. The Recipient agrees that no third-party beneficiary status or any other right of action is created in favor of any contractor, subcontractor, materialmen or other third party against Harriman by virtue of this Agreement or in connection with its delivery of Electronic Documents, and no third-party beneficiary status is intended.
20. Recipient further agrees to indemnify and save harmless Harriman and its subconsultants and each of their partners, officers, shareholders, and directors and employees from any and all claims, judgments, suits, liabilities, damages, costs or expenses (including reasonable defense and attorney's fees including claims asserted in breach of contract, breach of warranty, negligence, or any other tort) arising as a result of either: 1) Recipient's failure to comply with any of the requirements of Agreement for the Delivery of Documents in Electronic Format; or 2) a defect, error or omission in the Electronic Documents or the information contained therein, which defect, error or omission was not contained in the Contract Documents as defined in Paragraph 2 or where the use of such Contract Documents would have prevented the claim, judgment, suit, liability, damage, cost, or expense.
21. Harriman reserves the right to deny a request to translate files.

AUTHORIZED ACCEPTANCE

By Recipient

By Harriman (Architect/Engineer of Record)

Signature

Signature

Print Name and Title

Print Name and Title

Date

Date

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SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The intent of this section is to require the Contractor to provide qualified testing expertise to organize, schedule, coordinate, and perform functional performance testing prior to commissioning of building's mechanical systems.
- B. The Commissioning Agent shall be contracted directly with the Owner. The Contractor shall coordinate with and provide assistance to the Commissioning Agent as described in this section. The Commissioning Agent shall be a Registered Professional Engineer in the State of Maine. The individual shall have close working knowledge of the systems (for example, the System Designer) in the building and shall be independent from the Installing Contractor.
- C. Provide the services of Subcontractors as appropriate in planning and performing testing and troubleshooting of equipment and systems as described in these specifications prior to and during the commissioning of the mechanical systems.
- D. Provide a complete commissioning of the HVAC systems, Plumbing systems, and the building envelope as applicable.

1.2 QUALITY ASSURANCE

- A. References
 - 1. ASHRAE Guideline 1.1-2007 - HVAC&R Technical Requirements for The Commissioning Process.
 - 2. SMACNA HVAC Systems Commissioning Manual - First Edition - October 1994

1.3 DOCUMENTATION

- A. Provide the Commissioning Agent with the following:
 - 1. Project Plans and Specification (Contract Documents), including authorized revisions and addenda.
 - 2. Final approved HVAC (and Plumbing, as applicable) Shop Drawings and Submittals.
 - 3. Final approved Test and Balancing Report.
 - 4. Equipment Start-up and Certification Reports.
 - 5. Any other documentation deemed by the Commissioning Agent to be pertinent to the commissioning process.

1.4 SUBMITTALS

- A. Prior to starting the commissioning process, the Commissioning Agent shall submit to Owner for approval a detailed commissioning schedule.
- B. When the commissioning process is completed, the Commissioning Agent shall submit final copies of the commissioning report to the following:
 - 1. 2 copies to the Owner.
 - 2. 1 copy to the Contractor.

3. 1 copy to the Architect.

1.5 RESPONSIBILITIES

A. Contractor Responsibilities:

1. Verify completeness of the building envelope, perimeter and interior items which affect proper operation and control of HVAC (and Plumbing, as applicable) equipment and systems.
2. Ensure participation and cooperation of specialty Subcontractors (including, but not limited to Electrical, Testing & Balancing and Controls) as required to facilitate the commissioning process.
3. Ensure participation of the Controls Subcontractor in demonstrating, in the presence of the Commissioning Agent, the proper sequence of operation of all equipment associated with Division 23.
4. Provide labor, material, equipment, and appurtenances, required to facilitate the commissioning process, including seasonal testing required after the initial commissioning. Perform test and verification procedures required by the commissioning process when requested by the Commissioning Agent.
5. Review functional start-up and performance tests and documentation required by the Contract Documents and equipment manufacturers, for equipment and systems, as performed by Subcontractors and vendors.
6. Develop schedules for testing, integrate testing into the master construction activity schedules, and coordinate Subcontractors' start-up procedures as required. Update as required.
7. Follow manufacturer's start-up procedures and provide documentation of equipment start-up, system functional tests, and cross-system functional tests. Start-up procedures shall be in accordance with equipment manufacturer's recommendations, where applicable. Start-up procedures shall fully describe system configuration and steps required for each test, appropriately documented so that another party can repeat the procedure with virtually identical results.
8. Submit start-up and test procedure schedule, procedures, forms, and other documentation to the Commissioning Agent and the Owner for approval two months prior to starting any testing.
9. Provide written notice to Commissioning Agent and the Owner when systems have been successfully started in accordance with manufacturer's guidelines and project document requirements and are ready for commissioning.
10. Coordinate Subcontractors on the project specific to their responsibilities and contractual obligations.
11. Provide engineering and technical expertise to oversee and direct the correction of deficiencies found during the commissioning process.
12. Observe the start-up and testing of equipment by Subcontractors.
13. Manage cross-system testing such as HVAC, building automation, fire alarm, emergency power, and life safety.
14. Note any inconsistencies or deficiencies in system operations and enforce system compliance or recommend to the Architect modification of system design which will enhance system performance.
15. Coordinate with the Architect/Engineer (A/E), Commissioning Agent, and Owner during commissioning final test procedures, after verifying that pretests have been satisfactorily conducted and final tests are ready to be performed.
16. In the event that a functional test performed by or in the presence of the Commissioning Agent fails, determine the cause of failure and rectify the problem as soon as possible,

and then retest. If more than two functional tests of the same system(s) are required, reimburse associated costs for the extraordinary participation of the A/E, Commissioning Agent, and Owner's staff, as required by the particular test being performed.

17. Review operations and maintenance information and as-built drawings provided by the various Subcontractors and vendors for verification, organization and distribution.
18. Obtain documentation from tests and assemble a final test report to be submitted to the Architect and the Commissioning Agent for approval.
19. As HVAC and Plumbing systems become ready for commissioning, notify the Commissioning Agent by "signing off" on the commissioning readiness checklist, which shall be prepared by the Commissioning Agent and presented to the Contractor. Commissioning of HVAC and Plumbing systems shall not be performed until they have been "signed off" by the Contractor.
 - a. If an HVAC or Plumbing system has been "signed off" as "INSTALLATION COMPLETE PER DRAWINGS AND SPECIFICATIONS" and/or "OPERATING IN ACCORDANCE WITH SPECIFIED SEQUENCE OF OPERATION" (see "HVAC SYSTEMS READINESS CHECKLIST" below) and the Commissioning Agent discovers any obvious deficiencies which clearly indicate that good faith effort has not been made to confirm proper system installation and/or operation, the Contractor shall reimburse associated costs for the extraordinary participation of the A/E, Commissioning Agent, Construction Manager and Owner's staff. The reimbursement amount shall be, at a minimum, 1/2 hour of the Commissioning Agent's hourly billing rate.

B. Commissioning Agent Responsibilities:

1. Plan, organize, and implement the commissioning process as specified herein.
2. Prepare the commissioning plan and ensure its distribution for review and comment.
3. Revise the commissioning plan as required during construction.
4. Chair commissioning meetings and prepare and distribute minutes to commissioning team members, whether or not they attend the meeting,
5. Coordinate commissioning activities with the Contractor.
6. Ensure required instruction and demonstrations are provided to the Owner's designated operating staff.
7. Work with the Contractor in the development and execution of the commissioning program.
8. Review the Contractor's system start-up plans.
9. Review the Contractor's equipment and component test procedures.
10. Review the Contractor's systems and inter-systems functional performance test procedures.
11. Witness, verify, and approve satisfactory completion of equipment and component tests and systems and inter-systems functional performance tests.
12. Review and approve specified documentation.
13. Coordinate participation of Owner's personnel involved with equipment, component and system performance verification and participation in required training.
14. When commissioning has been successfully completed, recommend final acceptance to the Owner.
15. Communicate as follows:
 - a. Formally communicate with the Contractor via approved project channels.
 - b. Keep the Owner advised regarding commissioning activities, progress, problems which may develop, solutions to problems, systems performance, and schedules.

C. Owner Responsibilities:

1. If desired, schedule personnel to participate in HVAC and Plumbing commissioning process.
2. Work with the Commissioning Agent and the Contractor as required to schedule commissioning work in occupied areas.
3. Advise the Commissioning Agent regarding change in building occupancy and/or usage.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DOCUMENTATION

- A. The Commissioning Agent shall prepare a commissioning readiness checklist which shall be used by the Contractor as “sign off” of readiness of systems for commissioning. The commissioning readiness checklist shall list individually systems which shall be commissioned. Submit the commissioning readiness checklist to the Architect for approval. Once the Architect has approved the commissioning readiness checklist, furnish it to the Contractor for his use. As systems become ready for commissioning, the Contractor shall sign and date the appropriate areas and shall submit copies to the Architect and the Commissioning Agent.
COMMISSIONING OF SYSTEMS SHALL NOT BE PERFORMED UNTIL THEY HAVE BEEN “SIGNED OFF” BY THE CONTRACTOR.
- B.
- B. The Commissioning Agent shall submit the following to the Architect for approval before commissioning of mechanical systems begins:
 1. Detailed procedures for testing to be performed by each party in the commissioning process.
 2. Samples of report forms that will be used to submit test data and results.
 3. Calibration data for test equipment.
 4. Sequence and schedule of procedures.
- C. The final commissioning report shall include the results of commissioning tests performed on the following systems:
 1. Every mode of systems operation, system equipment, components and zones, and every item in the automatic temperature controls sequence of operation description shall be proven operational under normal operational modes, including part and full load, and under abnormal or emergency conditions. This shall include, but not be limited to, the following:
 - a. AHU & damper response to smoke detectors.
 - b. Air handling units.
 - c. Condensing units/Air conditioning systems.
 - d. Control dampers.
 - e. Control valves.
 - f. Filters - Verify that filters are in place.
 - g. Fans.
 - h. Thermostats & temperature sensors - Verify proper calibration.
 - i. Unit Ventilators.
 - j. Each system shall be tested through all modes of system operation (for example,

seasonal, occupied/unoccupied, warm-up/cool-down, as applicable) including every individual interlock and conditional control logic, control sequences, both full- and part-load conditions, and simulation of abnormal conditions for which there is a specified system or controls response.

2. Verify the performance of life safety devices and systems that interface with HVAC systems.
3. Verify proper calibration of thermostats and temperature sensors.
4. Verify readings of remote data and control systems, such as:
 - a. Air temperatures
 - b. Water temperatures
 - c. Air Flow (CFM)
 - d. Damper positions
 - e. Control valve positions

D. Any approved changes in system operation shall be documented by the Commissioning Agent.

END OF SECTION 019113

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SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of building or structure.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 FIELD CONDITIONS

- A. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.

2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

PART 2 - EXECUTION

2.1 EXAMINATION

- A. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

2.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

2.3 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 3. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 4. Dispose of demolished items and materials promptly.
- B. Removed and Reinstalled Items:
 1. Clean and repair items to functional condition adequate for intended reuse.
 2. Protect items from damage during transport and storage.
- C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

2.4 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."

2.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

2.6 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

PART 3 - EXECUTION – NOT USED

END OF SECTION 024119

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SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Framing with dimension lumber.
 2. Framing with engineered wood products.
 3. Wood blocking and nailers.
 4. Wood furring.
 5. Composite insulating wall sheathing.
 6. Plywood backing panels.
 7. Wood blocking at all wall hung equipment including fire extinguishers, toilet partitions, accessories, shelving, door stops and any other Owner or Contractor supplied equipment.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- B. Evaluation Reports: For the following, from ICC-ES:
1. Wood-preservative-treated wood.
 2. Engineered wood products.
 3. Metal framing anchors.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 4. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.
- C. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
 - 1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- D. Wood Structural Panels:
 - 1. Plywood: DOC PS 1.
 - 2. Thickness: As needed to comply with requirements specified but not less than thickness indicated.
 - 3. Factory mark panels according to indicated standard.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
 - C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
 - D. Application: Treat items indicated on Drawings, and the following:
 1. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 2. Wood framing and furring attached directly to the interior of exterior concrete walls.
 3. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 DIMENSION LUMBER FRAMING

- A. Load-Bearing, Joists, Rafters, Nailers for Steel Beams, Structural Blocking, and Other Framing: No. 2 grade or better.
 1. Species:
 - a. Douglas Fir, Douglas Fir-Larch.
 - b. Spruce-pine-fir; NLGA.
 2. Spruce-pine-fir (South) is not acceptable, except where pressure-treated materials are indicated.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
 3. Furring.
- B. For items of dimension lumber size, provide No. 2 grade lumber and any of the following species:
 1. Spruce-pine-fir; NLGA.
- C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2 inch (12.7 mm) nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.7 METAL FRAMING ANCHORS

- A. Product: Subject to compliance with requirements, provide Simpson product indicated on Drawings.
- B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of products indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- C. Materials:
 - 1. Interior Locations: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G90 coating designation.

2.8 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4-inch-thick, selected from manufacturer's standard widths to suit width of sill members indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- D. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.
- F. Do not splice structural members between supports unless otherwise indicated.
- G. Do not use panel materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- H. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
- I. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- J. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal-thickness.
 - 3. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.
- K. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- L. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- M. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
 - 1. Install blocking for grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.
 - 2. Provide concealed wood blocking behind gypsum wallboard where door stops are to be wall mounted.
 - 3. Provide fire retardant treated wood and plywood where indicated.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Where wood-preserved-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

3.4 WALL AND PARTITION FRAMING INSTALLATION

- A. General: Provide single bottom plate and double top plates using members of 2-inch nominal thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction unless otherwise indicated.
 - 1. Provide continuous horizontal blocking at mid-height of partitions more than 96 inches high, using members of 2-inch nominal thickness and of same width as wall or partitions.
- B. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.

- C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
 - 1. For non-load-bearing partitions, provide double-jamb studs and headers not less than 4-inch nominal depth for openings 48 inches and less in width, 6-inch nominal depth for openings 48 to 72 inches in width, 8-inch nominal depth for openings 72 to 120 inches in width, and not less than 10-inch nominal depth for openings 10 to 12 feet in width.
 - 2. For load-bearing walls, provide double-jamb studs for openings 60 inches and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated or, if not indicated, according to Table R502.5(1) or Table R502.5(2), as applicable, in ICC's International Residential Code for One- and Two-Family Dwellings.

3.5 CEILING JOIST AND RAFTER FRAMING INSTALLATION

- A. Ceiling Joists: Install ceiling joists with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.
 - 1. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate and nail to first joist or anchor with framing anchors or metal straps. Provide 1-by-8-inch nominal-size or 2-by-4-inch nominal-size stringers spaced 48 inches o.c. crosswise over main ceiling joists.
- B. Rafters: Notch to fit exterior wall plates and use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
 - 1. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches deeper. Bevel ends of jack rafters for full bearing against valley rafters.
 - 2. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches deeper. Bevel ends of jack rafters for full bearing against hip rafter.
- C. Provide collar beams (ties) as indicated or, if not indicated, provide 1-by-6-inch nominal-size boards between every third pair of rafters, but not more than 48 inches o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.
- D. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions if any.

END OF SECTION 061000

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SECTION 064000 - ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Reception area.
 - a. Solid-surfacing-material countertops.
 - b. Plastic Laminate clad casework
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
 - 2. Division 22 Sections for plumbing and venting connections of integral sinks installed in solid surfacing countertops.

1.3 ACTION SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated, including accessories.
- C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show details full size.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Show locations and sizes of cutouts and holes for faucets and other items installed in architectural woodwork.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: An experienced Installer who has completed architectural woodwork similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Standards, First Edition" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soilage, and deterioration.
- B. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by accurate field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.
- B. Coordinate locations and sizes of plumbing fittings that will penetrate countertops.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Species and Cut for Transparent Finish: Eastern white pine or Douglas fir as selected by Architect.
- C. Wood Products: Comply with the following:
 - 1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade MD.
 - a. Provide moisture-resistant MDF within 2-feet of sinks and for vanity removable panel.
 - 1) Moisture Resistant: ASTM D 1037, 6-cycle accelerated aging test.
 - a) Product: SierraPine; Medex.
 - 2. Particleboard: ANSI A208.1, Grade M-2.
- D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
 - 1. Manufacturers: Wilsonart International.
 - 2. Colors, Patterns, and Finishes: As indicated in Materials Legend.
- E. Solid- Surfacing Material, SS1: Homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without a

precoated finish.

1. Product: Corian; DuPont Polymers
2. Color, Pattern, and Finish: As indicated in Materials Legend.

- F. Edge-banding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 1 mm and 3 mm thick, with radiused edges. Hot melt adhesive application.

2.2 CABINET HARDWARE

- A. Adjustable Shelf Standards and Supports for Exposed Locations:

1. Twin slotted, heavy duty, steel shelf standards and U-shaped, double prong, heavy-duty steel brackets, epoxy powder coat finish, color selected by Architect.
 - a. Products:
 - 1) Steel-Lok, Spur Shelving.

- B. Grommets for Cable Passage through Plastic Laminate Countertops: Molded-plastic grommets and matching plastic caps with slot for wire passage; color and size as selected by Architect during Shop Drawing review.

1. Manufacturer: Provide products from one of the following:
 - a. Doug Mockett and Co., Inc.
 - b. Outwater Plastics, (800) 631-8375.

2.3 ACCESSORY MATERIALS

- A. Counter Bracket Supports: Fabricated of 6063 T-6, T-shaped extruded aluminum; MIG welded along 45 degree miters and along back; pre-punched for 1/4-inch fasteners; provide rubber grommet in 7/8-inch hole; powder coated finish.

1. Size: Varies as required for condition; coordinate with Drawings.
2. Mounting Style: Exposed and concealed mounting; coordinate with Drawings.
3. Product: Rakks, Rangine Corp., Millis, MA.

- B. Vanity Bracket Supports: ADA compliant, C-shaped extruded aluminum with vertical rear leg for attachment to wall, horizontal member for supporting vanity top and vertical front leg with sloped return for attachment of front removable panel, Type 6063 T-6 aluminum alloy and temper.

1. Product: Rakks EHV Vanity Supports; Rangine Corp., Millis, MA.

2.4 MISCELLANEOUS MATERIALS

- A. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.5 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade indicated and any additional requirements of this Section. When quality grade is not indicated, provide Custom quality grade.

- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

- C. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 1. Edges of Solid-Wood (Lumber) Members 3/4 Inch Thick or Less: 1/16 inch.
 2. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.

 - D. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

 - E. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- 2.6 PLASTIC-LAMINATE COUNTERTOPS AND VANITY APRON & REMOVABLE PANEL
- A. Quality Standard: Comply with AWI's Standards Section 11 - Countertops requirements.
 - B. Grade: Custom.
 - C. High-Pressure Decorative Laminate Grade: HGS.
 - D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 1. As indicated in Materials Legend by manufacturer's designations.
 - E. Grain Direction: Parallel to cabinet fronts.
 - F. Core Material: Particleboard or medium-density fiberboard.
 - G. Core Material for Apron and Removal Panels at Vanities: Moisture-resistant medium-density fiberboard.
- 2.7 SOLID-SURFACING-MATERIAL COUNTERTOPS
- A. Quality Standard: Comply with AWI's Standards Section 11 - Countertops requirements for countertops.
 - B. Grade: Custom.
 - C. Solid-Surfacing-Material Thickness: As indicated.
 - D. Configuration: Provide countertops with the following front and backsplash style:
 1. Front: Built-up front edge in profile indicated.
 - a. Provide concealed drip kerf on underside of front edge at sinks.
 2. Backsplash: Provide integral cove where backsplash meets the top, chemically bonded. Flat, slightly eased at corner for top of backsplash, 3/4-inch- thick, with scribe edge.
 3. Endsplash: Matching backsplash.

- E. Colors, Patterns, and Finishes: As indicated in Materials Legend.
- F. Fabrication: Fabricate tops in one piece with integral chemically bonded shop-applied edges and backsplashes. Provide continuous 3/8-inch deep scribe strip along top back edge and ends of back splash. Provide built-up nosing with concealed drip groove. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose endsplashes for field assembly.
- G. Install integral sink bowls in countertops in shop.
- H. Drill holes in countertops for plumbing fittings and grommets in shop.

2.8 ACCESS TOTE TRAY STORAGE CABINETS

- A. Manufacturer: Diversified Woodcrafts, School Outfitters, 3736 Regent Ave., Cincinnati, OH 45212. (866) 619-1776.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back-priming.

3.2 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
 - 1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and

- finish same as wood base if finished.
2. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.
- G. Plastic Laminate Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
1. Install countertops level and true in line. Use concealed shims as required to maintain not more than 1/8-inch-in-96-inches sag, bow, or other variation from a straight, level plane.
 2. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c.
 3. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.
 4. Install countertop brackets specified in Part 2. Painting of bracket specified in Division 09 Section "Painting."
 5. Caulk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
- H. Countertops, Solid-Surfacing Materials: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
1. Align adjacent solid-surfacing-material and quartz agglomerate countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 3. Secure backsplashes and end splashes to tops to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 4. Install countertop brackets specified in Part 2. Painting of bracket specified in Division 09 Section "Painting."
 5. Caulk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
- I. Solid-Surfacing Vanity Tops: Anchor securely by screwing through vanity bracket support into underside of countertop.
1. Install vanity tops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 2. Secure backsplashes and end splashes to tops to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 3. Install vanity top brackets specified in Part 2.
 4. Attach plastic laminate apron and removable panel to vanity top bracket.
 5. Caulk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
- J. Refer to Division 09 Section "Painting" for final finishing of installed architectural woodwork.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064000

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SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
 - 1. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and borrowed lites.
 - d. Joints between interior simulated stone veneer and adjacent finishes.
 - e. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - f. Other joints as indicated.
- B. Related Sections include the following:
 - 1. Division 06 for sealing joints related to PVC trim and adjacent materials.
 - 2. Divisions 22, 23, and 26 for sealing of perimeter joints of plumbing, HVAC systems, telecommunication systems, and electrical systems.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide joint sealants that have been produced and installed to establish and maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittals Procedures."
- B. Product Data: For each joint-sealant product indicated.
 - 1. Include manufacturer's installation instructions.
- C. Samples for Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint design, including width and depth of joint sealant, and backer rod or bond-breaker size and location.
 - 3. Joint-sealant manufacturer and product name.
 - 4. Joint-sealant formulation.
 - 5. Joint-sealant color.

6. Primer for each substrate type.
7. Solvent wipe cleaner for each substrate type.
8. For sealants and sealant primers used inside the weatherproofing system, including printed statement of VOC content.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in materials, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, shelf/pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- C. Remove and replace materials, at no cost to Owner, that cannot be applied within their stated shelf life.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation to ensure a weathertight installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other

Part 2 articles.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. Exposed Joint Sealants: Products exposed to view in interior public areas shall be paintable. Mechanical, electrical and elevator machine rooms are not considered public spaces.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 JOINT SEALANTS

- 1. Interior Sealants and Primers: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to South Coast Air Quality Management District Rule No. 1168:
 - a. Sealants:
 - 1) Architectural: 250 g/L.
 - b. Sealant Primers:
 - 1) Architectural, Nonporous: 250 g/L
 - 2) Architectural, Porous: 775 g/L.
 - 3) Other: 750 g/L.
- B. Type 3 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, single component, paintable.
 - 1. Products:
 - a. Tremflex 834; Tremco.
 - b. AC-20; Pecora Corporation.
 - c. Chem-Calk 600; Bostik Findley.
- C. Type 4 - Plumbing Fixture/Tile Sealant: Silicone; ASTM C920, Uses M and A; single component, mildew resistant, color selected by Architect.
 - 1. Products:
 - a. 898 Silicone; Pecora Corporation.
 - b. Tremsil 200 Sanitary; Tremco, Inc.

2.4 JOINT-SEALANT BACKING

- A. General: Provide sealant backings (backer rods) of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Plastic Foam Joint Fillers (Backer Rod): ASTM E C 1330, Type C, preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - 1. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-

adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a

combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.

3. Remove laitance and form-release agents from concrete.
4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. **Joint Priming:** Prime joint substrates, where indicated or recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

1. Simulated stone and concrete surfaces shall be primed.

C. **Masking Tape:** Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. **General:** Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. **Sealant Installation Standard:** Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. **Installation of Sealant Backings (Backer Rods):** Install sealant backings to comply with the following requirements:

1. Install sealant backings of type indicated to provide support of sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - a. Do not leave gaps between ends of sealant backings.
 - b. Do not stretch, twist, puncture, or tear sealant backings.
 - c. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
2. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and joint fillers or backs of joints.

D. **Installation of Sealants:** Install sealants using proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings and primers are installed.

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. **Tooling of Nonsag Sealants:** Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Joints between Plumbing Fixtures and Walls and Floors and Between Countertops and Walls: Type 4; colors as selected.
- B. Interior Joints for Which No Other Sealant is Indicated: Type 3; colors as selected.

END OF SECTION 079200

SECTION 092950 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum wallboard applied to wood and steel framing.
 - 2. Sound board.
 - 3. Tile backing panels, including cementitious backer panels.
 - 4. Non-load-bearing steel framing.
 - 5. Interior suspension systems.
 - 6. Acoustical batt insulation in metal-framed assemblies.
 - 7. Acoustical sealants.
 - 8. Firestopping at wall and partition perimeters of fire-rated construction.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for concealed wood blocking in gypsum board assembly walls and wood framing.
 - 2. Division 07 Section "Joint Sealants" for sealants not covered by work of this Section.
 - 3. Division 09 Section "Painting" for coordination/inspection requirements with painting contractor and primers applied to gypsum board surfaces.

1.3 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
 - 1. VOC Content of Sealants: For sealants used inside the weatherproofing system, include a printed statement of the VOC content.
- C. Shop Drawings: Show locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.

1. Submit marked up floor plans with location of all control joints in gypsum board walls and ceilings.
2. Firestopping: For each joint condition where fire-rated walls and partitions interface other walls, floors, structural members or other building structure, provide UL firestop system description and drawing. Show each kind of construction condition and relationships to adjoining construction. Indicate which firestop materials will be used where and thickness for different hourly ratings. Include UL firestop design designation that evidences compliance with requirements for each condition.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory," GA-600, "Fire Resistance Design Manual," or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Deflection Firestop Track: Top runner indicated in fire-resistance-rated assemblies shall be labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Gypsum Board Finish Mockups: Before finishing gypsum board assemblies, install mockups using room designated by Architect to demonstrate aesthetic effects and qualities of materials and execution.
 1. Install mockups for surfaces indicated to receive nontextured paint finishes.
 2. Simulate finished lighting conditions for review of mockups.
 3. Mockup will be painted under Division 09 Section "Painting" to provide finished condition for viewing.
 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
- C. Stack gypsum panels flat on leveled supports off floor or slab to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
- D. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F. Do not exceed 95 deg F when using temporary heat sources.
- E. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 NON-LOAD-BEARING STEEL FRAMING, GENERAL

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized, unless otherwise indicated.

2.3 STEEL SUSPENDED CEILING AND FRAMING

- A. Manufacturers:
 - 1. Clark Dietrich Building Systems.
 - 2. E.B. Metal US.
 - 3. MarinoWare; Division of Ware Ind.
 - 4. Super Stud Building Products, Inc.
- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0625-inch-diameter (8-gage) wire, or double strand of not less than 0.099-inch- diameter (12-gage) wire.
- C. Hangers: As follows:
 - 1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter (8-gage).
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch, a minimum 1/2-inch- wide flange, with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
 - 1. Depth: 2 inches, unless indicated otherwise.

- E. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.
 - 1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep; where indicated.
 - a. Minimum Base Metal Thickness: 0.0312 inch (22 gage).
- F. Hand-Formable Radius Tracks: Factory fabricated runner track, providing smooth, non-segmented continuous one-piece shape; 0.0329 inch thick, 20 gage; size as indicated.
 - 1. Products: Provide the following products by Radius Track Corporation, (888) 872-3487:
 - a. Hand-Formable Ready-Track.
- G. Grid Suspension System for Interior Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock, heavy-duty.
 - 1. Products:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; 640-C Drywall Furring System.
 - c. USG Interiors, Inc.; Drywall Suspension System.
 - d. Provide comparable system where fire-rated ceilings are indicated.

2.4 STEEL PARTITION AND SOFFIT FRAMING

- A. Steel Studs and Runners, Gauge Equivalent Drywall Framing: ASTM C 645.
 - 1. Minimum Base Metal Thickness: Minimum 0.030 inch (25 gage equivalent studs) to meet deflection criteria and to allow for the hanging of medical equipment on walls.
 - 2. Depth: As indicated.
 - 3. Maximum Allowable Deflection: Increase metal thickness where required to meet the following:
 - a. Maximum Allowable Deflection for Drywall Assemblies: $L/240$ calculated using a 5 pound per square uniform load perpendicular to studs and based on stud properties alone.
 - b. Maximum Allowable Deflection for Drywall Assemblies Receiving Tile and Cementitious Backing Panels Receiving Simulated Stone Veneer: $L/360$ calculated using a 5 pound per square uniform load perpendicular to studs and based on stud properties alone.
 - 4. Products:
 - a. Clark Dietrich Building Systems; ProSTUD.
 - b. MarinoWare; Division of Ware Ind.; ViperStud.
 - c. Super Stud Building Products, Inc.; The Edge Framing.
- B. Deep-Leg Deflection Track: ASTM C 645 top runner with flanges to allow for 3/4-inch deflection at floors and 1-1/2 inch at roofs.
- C. Firestop Deflection Track: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs. Provide deflection track with flanges to allow for 3/4-inch deflection at floors and 1-1/2 inch at roofs. Track shall be rated for wall construction where it is located.
 - 1. Product: Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base Metal Thickness: 0.0598 inch (16 gage), unless indicated otherwise.

- E. Cold-Rolled Channel Bridging: 0.0538-inch (16 gage) minimum bare steel thickness, with minimum 1/2-inch- wide flange.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch- thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 0.0312 inch (20 gage).
 - 2. Depth: 7/8 inch, unless otherwise indicated.
- G. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Asymmetrical.
- H. Furring Brackets: Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C 645, 20 gauge, .0329 inch, designed for screw attachment to steel studs and steel rigid furring channels used for furring.
- I. Deflection Brackets:
 - 1. Construction: Slotted galvanized steel angle with step bushing to prevent over tightening of fasteners.
 - 2. Vertical Deflection: 1-1/2 inch total travel.
 - 3. Product: VertiClip; Signature Industries, (919) 844-0789.
 - a. Series: SL, SDL, SLB, and SLS as required by attachment condition.
- J. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.

2.5 PANELS, GENERAL

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Manufacturers: Unless indicated otherwise, provide products by one of the following:
 - 1. G-P Gypsum Corporation.
 - 2. National Gypsum Company.
 - 3. United States Gypsum Company.

2.6 INTERIOR GYPSUM WALLBOARD

- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
- B. Type X, GPDW:
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
 - 3. Face Sheets: 100 percent post-consumer recycled content.
 - 4. Location: All locations, except as otherwise noted.

- C. Moisture- and Mold-Resistant Type, GPDW-MR: ASTM C 1396/C 1396M with moisture- and mold-resistant core and surfaces.
 - 1. Core: 5/8 inch, Type X.
 - 2. Long Edges: Tapered.
 - 3. Mold-Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
 - 4. Face Sheets: 100 percent post-consumer recycled content.
 - 5. Location: Interior face of all exterior walls; walls and ceilings of toilet rooms and janitor closets, except as indicated otherwise; and where indicated.
 - a. Note: Do not use moisture- and mold-resistant board behind tile; use tile backer board behind tile on walls.
 - 6. Products:
 - a. G-P Gypsum Corp.; Toughrock Mold-Guard Gypsum Board.
 - b. National Gypsum Co.; Gold Bond Brand XP Gypsum Board.
 - c. United States Gypsum Co.; Mold Tough Panels.

- D. Sound Board: Molded panels composed of recycled, post-consumer paper and cellulose fiber, free of asbestos or formaldehyde, 1/2-inch thick.
 - 1. Product: Homasote Company; 440 Sound Barrier.

2.7 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: Complying with ASTM C 1178/C 1178M.
 - 1. Core: 5/8 inch, Type X.
 - 2. Mold-Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
 - 3. Products:
 - a. G-P Gypsum Corporation; DensShield Tile Guard.
 - b. National Gypsum Company; Gold Bond eXP Tile Backer Panel.
 - 4. Locations: Behind wall tile and where indicated.

- B. Cementitious Backer Units: ANSI A118.9.
 - 1. Product: United States Gypsum Co.; DUROCK Cement Board.
 - 2. Thickness: 1/2 inch.
 - 3. Location: Behind interior simulated stone veneer.

2.8 PVC LINER PANELS

- A. PVC Interlocking Liner Panel
 - 1. 0.50" thick, 16" wide, Bright White interlocking panels
 - 2. ASTM E84-17a, Class A
 - 3. Product:
 - a. Duraclad PVC Interlocking Liner Panel

2.9 TRIM ACCESSORIES

- A. Interior Metal Trim: ASTM C 1047, galvanized steel.
 - 1. Shapes:
 - a. Cornerbead: 1-1/4 inch x 1-1/4 inch external corner with 1/8-inch nose bead. Use at outside corners, unless otherwise indicated.
 - b. LC-Bead (Casing): J-shaped casing with 1/16-inch nose bead ground, not less than 30 gage; exposed long flange receives joint compound; use at exposed panel edges.
 - c. Expansion (Control) Joint: One-piece control joint formed with V-shaped slot and removable strip covering slot opening.

- d. Curved-Edge Cornerbead: With notched or flexible flanges; use at curved openings.
- 2. Accessories for Curved Edges: Corner bead formed of metal, plastic, or metal combined with plastic, with either notched or flexible flanges that are bendable to curvature radius.

2.10 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper reinforcing tape.
 - a. If fiberglass tape is considered for use, it shall be USG Sheetrock Brand with cross-laminated construction, NO substitution, with setting type compound only for first and second coats.
 - 2. Glass-Mat, Water-Resistant Tile Backing Panels: As recommended by panel manufacturer.
- C. Setting-Type Joint Compound: Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.
 - 1. Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.
 - 2. For topping compound, use sandable formulation.
- D. Drying-Type Joint Compound: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
 - 1. Ready-Mixed Formulation: Factory-mixed product; all-purpose compound formulated for both taping and topping compounds.
- E. Type of Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound or drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.
- F. Joint Compound for Tile Backing Panels:
 - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by manufacturer.
 - a. Use setting type compound only for panels receiving tile finishes.
 - 2. Cementitious Backer Units: As recommended by manufacturer.
 - a. Use setting type compound only for panels receiving simulated stone finishes.

2.11 ACOUSTICAL SEALANT

- A. Products:
 - 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.

- b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.
 - 2. Acoustical Sealant for Concealed Joints:
 - a. Ohio Sealants, Inc.; Pro-Series SC-175 Acoustical Sound Sealant.
 - b. Pecora Corp.; AIS-919.
 - c. Tremco, Inc.; Tremco Acoustical Sealant.
- B. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- C. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

2.12 SEALANTS FOR FIRE-RESISTANCE-RATED CONSTRUCTION

- A. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. VOC Content of Fire-Resistance-Rated Sealants and Primers: Shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Joints in or between Fire-Resistance-Rated Construction: Materials shall comply with installation requirements in Division 07 and submitted UL assemblies.
 - 1. Provide firestopping where fire rated gypsum board assemblies butt trusses, joists, beams, and structural members as part of the gypsum board assembly work.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
 - 3. Joints shall be sealed with fire-resistance-rated sealants; use of joint compound for sealing of joints is not permitted.
- D. Sealants for joints in or between smoke partitions shall be resistant to not less 400 deg F.
- E. Exposed Fire-Resistive Joint Sealants: Exposed sealants shall be paintable.

2.13 SOUND ATTENUATION INSULATION

- A. Sound Attenuation Batts (SAB): ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool or rock wool that is fire resistance in accordance with ASTM E 136 and sound control in accordance with ASTM E 423; designed to reduce airborne sound transmission; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Thermal fiberglass insulation not allowed.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of UL assemblies indicated.
 - 2. Sound Attenuation Batts (SAB) in Wall Assemblies: Provide in thickness for full depth

of cavity. Where cavity requires insulation that is thicker than standard size, install next larger size and compress into cavity.

3. Products:
 - a. Johns Manville; Fiberglass Sound Control Batts.
 - b. Knauf Insulation; EcoBatt Quiet Therm Acoustical/Thermal Batt Insulation.
 - c. Owens Corning; Sound Attenuation Batt Insulation.

B. Thermal Insulation: As specified in Division 07.

2.14 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Fastening gypsum board to steel members: Type S bugle head.
2. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
3. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. Polyethylene Vapor Retarder: As specified in Division 07.

D. Insulation Support Anchors: Continuous, galvanized metal support strip, 25 gage, with pre-punched tabs at 8 inches on center.

1. Product: Insul-hold; Insul-Hold Co., Inc.; phone (207) 465-9066.

E. Firestopping:

1. Provide firestopping where fire rated gypsum board assemblies butt trusses, joists, beams, and structural members as part of the gypsum board assembly work. See Division 07.
2. Penetrations through fire-resistant rated walls and partitions by Divisions 22, 23, 26, and 27 work, including both empty openings and openings containing cables, pipes, ducts and conduits are specified as part of the Divisions 22, 23, 26 and 27 work. Sealing of penetrations shall be in accordance with Division 07.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Post-Installation Inspection: Inspect walls for dents and imperfections, with Installer and painter present, prior to painting. Verify exposed joints are finished up to required heights (to above acoustical ceilings). Inspect wall again after primer and first coat of paint applied, with Installer and painter present. Installer shall touch-up as follows:

1. Touch-up visible gypsum board imperfections before priming of walls.

2. Touch-up imperfections found in field of boards and joints made visible from painting after first finish coat applied.
3. Joint compound touch-up shall be primed and painted and viewed for acceptability before final coat is applied.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
- B. Prior to installing interior partitions in Clinical portion of the building, run gypsum board continuously over continuous rigid insulation provided in Division 07 on underside of trusses. Install gypsum board in accordance with requirements indicated in "APPLYING AND FINISHING PANELS, GENERAL" article below.

3.3 STEEL FRAMING INSTALLATION, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
 1. Comply with requirements of UL assemblies indicated for fire-rated construction.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."
- D. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.
 1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
 2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
 - a. Allow for 3/4-inch deflection at floors and 1-1/2 inches at roofs.
 - b. Install deflection track top runner or deflection brackets to attain lateral support and avoid axial loading.
 - c. Install deflection firestop track top runner at fire-resistance-rated assemblies.
 - 1) Attach jamb studs at openings to tracks using manufacturer's standard stud clip.
- E. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.4 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by

building structure to prevent transfer of loading imposed by structural movement.

- C. Suspend ceiling hangers from building structure as follows:
 - 1. Install hangers plumb and free from 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 and offset resulting horizontal forces by bracing, countersplaying, 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 support ceiling loads within performance limits established by referenced standards.
 - 3. Wire Hangers: Secure wire hangers by wire-tying, either directly to structures or to eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 - 4. Do not connect or suspend steel framing from ducts, pipes, or conduit. Attach hangers to structural members.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
- F. Sway-brace suspended steel framing with hangers used for support.
- G. Wire-tie furring channels to supports, as required to comply with requirements for assemblies indicated.
- H. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
 - 1. Hangers: 48 inches o.c.
 - 2. Carrying Channels (Main Runners): 48 inches o.c.
 - 3. Furring Channels (Furring Members): 16 inches o.c.
- I. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
 - 1. Fire-Rated Ceilings:
 - a. Butt Joints: Provide extra cross tees spaced 8 inches or less on either side of the butt joint.
 - b. Fire Relief Notch: Provide a hanger wire installed adjacent to fire relief notch.

3.5 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
- C. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.

- D. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at continuous gypsum board over rigid insulation on underside of wood trusses. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
1. Cut studs 1/2 inch short of full height to provide perimeter relief. Do not fasten studs to top track to allow independent movement of studs and track.
 2. For fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
 - a. Fire-resistance rated joint designs shall maintain integrity throughout repetitive deflection cycles.
- E. Install steel studs and furring at the following spacings:
1. Single-Layer Construction: 16 inches o.c., unless otherwise indicated.
 2. Multilayer Construction: 16 inches o.c., unless otherwise indicated.
 3. Cementitious Backer Units: 16 inches o.c., unless otherwise indicated.
- F. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
1. Attach both flanges to floor runner track with screws.
- G. Curved Partitions:
1. Cut top and bottom track (runners) through leg and web at 2-inch intervals for arc length. In cutting lengths of track, allow for uncut straight lengths of not less than 12 inches at ends of arcs.
 2. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 3. Support outside (cut) leg of track by clinching steel sheet strip, 1-inch- high-by-thickness of track metal, to inside of cut legs using metal lock fasteners.
 4. Begin and end each arc with a stud, and space intermediate studs equally along arcs at stud spacing recommended in writing by gypsum board manufacturer for radii indicated. Attach studs to bottom runners with 3/8-inch- long pan head framing screws into both flanges. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches o.c.
 5. Premanufactured Runner Option: Provide pre-manufactured radius runners to uniform curve of radius indicated and locate straight lengths so they are tangent to arcs.
- H. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
1. Install two studs at each jamb, unless otherwise indicated.
 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint.
 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above, even when partitions are not full height. Provide diagonal bracing at tall partitions to stop deflection and vibration of studs when doors are slammed shut.
 4. Extend jamb studs one-piece full height.
- I. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above

door heads.

- J. Installation Tolerance: Framing members shall be within the following limits:
 - 1. Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing, a total variation of 1/4 inch in 8 feet from a true plane.
 - 2. Layout of Walls and Partitions: 1/4 inch from intended position.
 - 3. Plates and Runners: 1/4 inch in 10 feet from a straight line.
 - 4. Studs: 1/4 inch in 10 feet out of plumb, not cumulative.
 - 5. Headers and Sills of Openings: 1/8 inch from level across width of opening.
 - 6. Soffits: 1/4 inch in 10 feet from level straight line.
 - 7. Spacing of Framing Members: Comply with requirements of ASTM C 754.

- K. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure. Install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
 - 1. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

3.6 INSTALLATION OF ACOUSTICAL INSULATION

- A. Install sound attenuation blankets (SAB) at locations indicated before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections that interfere with placement. Install insulation in voids as framing is installed that that would be inaccessible after completion of framing.

- B. Install a single layer of insulation of required thickness to fill the full depth of cavity, unless otherwise shown. Where cavity requires insulation that is thicker than standard size, install next larger size and compress into cavity.

- C. Hold batt insulation in place with insulation support anchors located at 5 feet on center full height of wall, starting at the top of each stud space.

- D. Stuff glass fiber loose fill insulation into miscellaneous voids and cavity spaces. Fill box headers, and voids while framing is being erected that will be inaccessible for installation later. Compact to approximately 40 percent of normal maximum volume (to a density of approximately 2.5 pcf).

3.7 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216, except as specified otherwise.
 - 1. Comply with requirements of UL assemblies indicated for fire-rated construction.

- B. Install acoustical insulation, where indicated, before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

- C. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attachment to Steel Framing: Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.
- I. Form control joints with space between edges of adjoining gypsum panels.
 - 1. Where control joints are not shown, provide control joints at a maximum spacing of 30 feet; review proposed locations with Architect prior to commencement of work.
- J. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless 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. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect beams, joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by beams, joists, and other structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
 - 4. Caulk fire-rated assemblies with fire-rated acoustical sealant on both sides of wall at head and sill to prevent the passage of smoke, gases and sound.
 - 5. Fire-resistance rated joint designs shall maintain integrity throughout repetitive deflection cycles
 - 6. Run board to within 1/4 inch of floor slabs to provide full support of resilient base.
- K. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with casing bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
 - 1. Use fire-rated acoustical sealant for fire-rated walls.
- L. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members, or provide control joints to counteract wood shrinkage.
- M. STC-Rated Assemblies: Where STC-rated assemblies are indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant on both sides of wall at head and sill. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

1. Joints to receive sealant shall be clean and dry, free of dirt, dust and debris.
- N. Fire-Rated Assemblies: Where fire-rated assemblies are indicated, seal construction at perimeters and behind control joints with continuous beads of fire-rated acoustical sealant on both sides of wall at head and sill. Comply with ASTM E 1966 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
1. Joints to receive sealant shall be clean and dry, free of dirt, dust and debris.
- O. Exterior Walls: Install continuous bead of acoustical sealant at base of all exterior walls sealing between edge of gypsum panels and wood subfloor. Install continuous bead of paintable acoustical sealant at top of all exterior walls sealing between edge of gypsum panel casing bead and underside of wood subfloor. Tool material smooth and uniform to insure good contact and adhesion to substrate.
1. Joints to receive sealant shall be clean and dry, free of dirt, dust and debris.
- P. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
1. Space screws a maximum of 12 inches o.c. for vertical applications.
- Q. Space fasteners in panels that are tile or simulated stone substrates a maximum of 8 inches o.c.
- R. Remove screws that do not hit studs, supports, or blocking and repair hole left by screw removal.

3.8 PANEL APPLICATION METHODS

- A. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- B. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud member and face-layer joints offset at least one stud member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
- C. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- D. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- E. Curved Partitions:
1. Install panels horizontally (perpendicular to supports) and unbroken, to the extent possible, across curved surface plus 12-inch-long straight sections at ends of curves and tangent to them.
 2. Wet gypsum panels on surfaces that will become compressed where curve radius

prevents using dry panels. Comply with gypsum board manufacturer's written recommendations for curve radii, wetting methods, stacking panels after wetting, and other preparations that precede installing wetted gypsum panels.

3. On convex sides of partitions, begin installation at one end of curved surface and fasten gypsum panels to studs as they are wrapped around curve. On concave side, start fastening panels to stud at center of curve and work outward to panel ends. Fasten panels to framing with screws spaced 12 inches o.c.
4. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.
5. Allow wetted gypsum panels to dry before applying joint treatment.

F. Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: Comply with manufacturer's written installation instructions and install at showers and locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.
2. Cementitious Backer Units: ANSI A108.11, at locations to receive simulated stone veneer.
3. Where tile backing panels abut other types of panels in the same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.9 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Install corner bead at external corners.
- C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.
 1. Install LC-bead (casing bead) where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
 2. Install U-bead where indicated.
 3. Curved-Edge Cornerbead: Use at curved openings.
- D. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
 1. Review locations of control joints with Architect prior to start of gypsum panel installation.

3.10 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, flanges of corner bead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, beveled edges, and damaged surface areas using setting-type joint compound.
- C. Apply joint tape over gypsum board joints and to flanges of trim accessories, except those with trim having flanges not intended for tape.

- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 - 1. Level 1: At ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 - 2. Level 2: At ceiling plenum areas, concealed areas, for tile substrates, for fire-resistance-rated assemblies, smoke assemblies and sound-rated assemblies, and where indicated.
 - 3. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
- E. Glass-Mat, Water-Resistant Backing Panels: Finish board forming base for ceramic and porcelain tile to comply with ASTM C 840 and according to manufacturer's written instructions for treatment of joints behind tile.
- F. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- G. Where Level 1 gypsum board finish is indicated, embed tape in joint compound. Surface shall be free of excess joint compound.
- H. Where Level 2 gypsum board finish is indicated, fill fastener heads, embed tape in joint compound and apply thin coat of joint compound over all joints and interior angles.
- I. For Level 4 gypsum board finish, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration.
 - 1. At tapered edge joints, draw compound down to a level plane, leaving a monolithic surface that is flush with paper face. Finish coat shall be feathered a minimum of 8 inches beyond both sides of center of joint tape.
 - 2. At end-to-end butt joints, draw compound down to minimize hump created by joint tape application. Finish coat shall be feathered a minimum of 16 inches beyond both sides of center of joint tape.
 - 3. End product shall be a surface that appears level without telegraphing joint locations as high spots when viewed down wall after painting.
 - 4. Finish board to within 1/4 inch of floor, providing full support for resilient wall base without telegraphing joint.

3.11 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
 - 1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 - 2. Before notifying Architect, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air-duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control-air tubing.
 - f. Installation of above ceiling automatic fire suppression piping, including leak and pressure testing.
 - g. Installation of ceiling support framing.

- h. Installation of fire stopping, smoke sealant and acoustical sealant work.

3.12 CLEANING

- A. Promptly remove any residual joint compound from adjacent surfaces.

3.13 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092950

SECTION 093100 - TILE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Glazed wall tile.
 - 2. Waterproof membrane for tile installations.
 - 3. Crack-suppression membrane for thin-set tile installations.
 - 4. Tile underlayment.
 - 5. Metal edge strips installed as part of tile installations.
- B. Related Sections include the following:
 - 1. Division 09 Section "Gypsum Board Assemblies" for glass-mat, water-resistant tile backer board.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces, both floors and walls.
- D. Samples for Initial Selection: For each type of grout indicated consisting of actual products showing full range of colors available. Include Samples of accessories involving color selection.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain all tile of same type from one source or producer.
 - 1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
 - 1. Waterproofing.
 - 2. Crack-suppression membrane.
 - 3. Metal edge strips and control joints.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.
2. Assemble all trades working at Project site to coordinate the work and to prevent workers from walking on newly installed tiles for required setting bed and grout cure times. Large tile will require additional time for the mortar bed to cure. Contractor to coordinate project schedule to complete work by other trades and vacate areas receiving floor coverings, stopping pedestrian traffic over newly installed flooring installation until curing and drying period is complete. Contractor shall conduct periodic coordination meetings with all trades to review schedule and procedures to prevent interference and damage during installation and curing and drying periods of floor coverings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
 1. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient and substrate temperatures and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.
 1. Maintain temperatures at 50 deg F or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.
- B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
 1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.2 TILE PRODUCTS

- A. Glazed Wall Tile, CT1: Wall tile as follows:
 - 1. Module Size: Nominal 3 by 12 inches, 3" x 12" cap.
 - 2. Face: Gloss Rippled with Square edges.
 - 3. Products: Emser Raku.
 - a. Colors: As indicated on Materials Legend.
- B. Glazed Wall Tile, CT2: Wall tile as follows:
 - 1. Module Size: Nominal 3 by 12 inches, 3" x 12" cap.
 - 2. Face: Matte Rippled with Square edges.
 - 3. Products: Emser Raku.
 - a. Colors: As indicated on Materials Legend.

2.3 WATERPROOF MEMBRANE FOR THIN-SET TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
 - 1. Products:
 - a. LATICRETE International Inc.; Laticrete 9235 Waterproof Membrane.
 - b. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh.

2.4 CRACK ISOLATION MEMBRANE FOR THIN-SET TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of a two-part, liquid rubber and fabric reinforcement.
 - 1. Products:
 - a. Laticrete International, Inc.; Laticrete Blue 92 Anti-Fracture Membrane.
 - b. MAPEI Corporation; Mapelastic AquaDefense.
 - c. Location: Use under porcelain floor tile at all cracks and control joints.

2.5 SETTING AND GROUTING MATERIALS

- A. Latex-Portland Cement Mortar (Thin Set) and Grout: ANSI A118.4 and ANSI A118.6 respectively, consisting of the following:
 - 1. Prepackaged premium dry-mortar mix combined with acrylic resin liquid-latex additive.
 - a. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.
 - b. For wall tile exceeding 10- by 10-inches, provide high performance, non-sag mortar.
 - 1) Products:
 - a) LATICRETE; Laticrete 254 Platinum.
 - b) MAPEI; Ultraflex 3.
 - 2. Grout Colors: As indicated on Materials Legend; in locations not indicated, as selected by Architect from manufacturer's full range of colors.
- B. Latex-Portland Cement Mortar for Large Format Tile, Medium Set on Floors: ANSI A118.4 and ANSI A118.6 respectively. Provide product that is approved by manufacturer for application thickness of up to 3/4 inch without shrinkage for tile with a dimension of 12-inches

or larger.

1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - a. Products:
 - 1) LATICRETE; Laticrete 255 MultiMax.
 - 2) MAPEI; Ultraflex LFT.
2. Grout Colors: As indicated on Materials Legend; in locations not indicated, as selected by Architect from manufacturer's full range of colors.

2.6 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Tile Underlayment (On Plywood Subfloor): Noncombustible, 1/4-inch thick panel fabricated of portland cement, ground sand, cellulose fiber and selected additives; containing no asbestos or formaldehyde.
 1. Product: James Hardie Building Products, Inc.; Hardibacker.
 2. Underlayment Accessories:
 - a. Setting Material: Latex portland cement mortar.
 - b. Tape: 2-inch wide fiberglass tape recommended by underlayment manufacturer.
- C. Metal Edge Strips at Tile: Stainless steel, L-shaped profile, 1/8-inch wide at top edge with integral provision for anchorage to mortar bed or substrate and integrated grout joint spacer.
 1. Finish: As selected by Architect.
 2. Height: As required for 3/8-inch thick tile plus setting bed so strip is flush with top of tile.
 3. Locations: Tile to carpet transitions, tile to resilient transition strip and where indicated.
 4. Product: Schluter Systems; Schluter-SCHIENE.
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.7 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions, including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.
- B. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Check flatness of substrate by laser. Level floor to provide a base for thin set that allows for a smooth, flat floor without irregularities. Grinding high spots until substrate is acceptable to the flooring Installer.
2. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
3. Verify that concrete substrates for tile floors installed with thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
4. Verify that gypsum board substrates for wall tile comply with the surface finish requirements in ANSI A108.01 for installations indicated and the following:
 - a. For Tile with all Edges less than 15 Inches: Flatness shall not vary more than 1/4-inch in 10 feet with no more than 1/16-inch variation in 12 inches when measured from the high points in the surface.
 - b. Verify that substrate is properly supported in corners.
 - c. Verify that fasteners are properly spaced and covered.
 - d. Verify that joint treatment is fully cured.
5. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 TILE UNDERLAYMENT INSTALLATION

- A. Stagger joints in underlayment board. Do not align with joints in existing flooring. Do not allow all four corners of sheets to meet at one point. Install cut sheet edges to the outside perimeter whenever possible.
- B. Set underlayment in a mortar bed, minimum 3/32-inch thick, allowing 1/8-inch gap between sheet edges. Screw attach to substrate every 6 inches o.c. each way over entire sheet. Set fastener heads flush with surface without over driving.
- C. Fill and level joints in underlayment board with same mortar, embed fiberglass mesh tape, and trowel smooth.

3.4 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Lay tile in patterns indicated. When field conditions conflict with indicated pattern, notify Architect in writing prior to installation for review and approval of revisions.
- D. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile. Top setting of coved base is not permitted.
- F. Tile shall lay flat and each edge flush with adjacent tile, free of tilting and skewed tile. Provide additional setting material to shim accent tiles that are thinner than field tiles so face is in same plane.
- G. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area, unless indicated otherwise. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- H. Lay out tile wainscots to next full tile beyond dimensions indicated.
- I. Grout tile to comply with requirements of the following tile installation standards:
 - 1. For ceramic tile grouts (latex-portland cement grouts), comply with ANSI A108.10.

3.5 WATERPROOFING AND CRACK-SUPPRESSION MEMBRANE INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.
 - 1. Install continuous fabric reinforcement over entire floor.
 - 2. Turn membrane with fabric reinforcement up walls as follows to keep water from traveling under partitions:
 - a. Toilet Rooms with Tile Floors on Elevated Slabs: 2 inches minimum at perimeter walls of rooms.
- B. Install crack-suppression membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate.
 - 1. Install fabric reinforcement in crack-suppression membrane at all cracks, saw cuts and room perimeter sealing.
 - 2. At Toilet Rooms and rooms with showers on slabs-on-grade with tile floors, seal perimeter of room by running membrane with reinforcement fabric up wall 2 inches minimum and out onto the floor 4 inches minimum.

- C. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.6 FLOOR TILE INSTALLATION

- A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.
 - 1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
 - a. Tile floors in wet areas.
 - b. Tile floors composed of tiles 8 by 8 inches or larger.
- B. Joint Widths: Install tile on floors with the following joint widths:
 - 1. Porcelain Tile: 1/8 inch.

3.7 WALL TILE INSTALLATION

- A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
- B. Joint Widths: Install tile on walls with the following joint widths:
 - 1. Glazed Wall Tile: 1/16 inch.

3.8 CLEANING AND PROTECTING

- A. Remove and replace material that is stained or otherwise damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove latex-portland cement grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
- C. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- D. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- E. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.9 TILE INSTALLATION SCHEDULE

- A. Porcelain Tile Floor Tile over Concrete Floors on Grade: Thin-set latex portland cement mortar tile setting bed over anti-fracture membrane applied to saw cuts and random cracks, TCAF125

- Partial.

1. At toilet rooms and rooms with showers, seal perimeter of room by running membrane with reinforcing fabric up wall 2 inches minimum and out on the floor 4 inches minimum.
- B. Porcelain Tile Floor Tile over Fiber Cement Underlayment over Wood Floor with Occupied Rooms Below: Thin-set latex portland cement mortar over waterproof membrane, TCA F144 modified.
1. At toilet room with shower, seal perimeter of room by running waterproof membrane up wall 4 inches minimum.
- C. Porcelain Wall Tile on Glass-Mat, Water Resistant Backer Board, Thin Set: Latex portland cement mortar tile setting bed, TCA W245.

END OF SECTION 093100

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Acoustical panels.
 - 2. Exposed suspension systems.
- B. Related Sections include the following:
 - 1. Division 09 Section "Gypsum Board Assemblies" for suspension systems provided for gypsum board ceilings.
 - 2. Division 22, 23, and 26 Sections for coordination of air handling devices, and electrical devices installed in ceiling systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Maintenance Data: For finishes to include in maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes. Store materials flat.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Mechanical, electrical, and other utility service installations above the ceiling plane shall have been completed prior to the installation of the ceilings.

1.6 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment and partition assemblies.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANELS, GENERAL

- A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
- B. Coating-Based Antimicrobial Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273.

2.2 ACOUSTIC PANELS

- A. Acoustic Panel: ACT1.
 - 1. Size: 24 inches x 24 inches.
 - 2. Thickness: 5/8-inch thick.
 - 3. Composition: Mineral wool fiber.
 - 4. Surface Finish: Factory-applied latex paint; white.
 - 5. Surface Texture: Fine texture.
 - 6. Edge: Beveled tegular.
 - 7. NRC Range: 0.50.
 - 8. CAC Range: 35.
 - 9. Dimensional Stability: Sag resistant at high humidity.
 - 10. Antimicrobial Treatment: Coating based, front and back.
 - 11. Product: Armstrong World Industries, Inc.; Dune No. 1775.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.
- E. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.
1. Locations: In Vestibules and for a distance of 10 feet inside exterior doors without Vestibules.

2.4 METAL SUSPENSION SYSTEMS FOR ACOUSTICAL PANEL CEILINGS

- A. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/653M, not less than G30 coating designation, with prefinished 9/16-inch- wide metal caps on flanges.
1. Structural Classification: Intermediate-duty system.
 2. Face Design: Flat, flush.
 3. Cap Material: Steel cold-rolled sheet.
 4. Cap Finish: Painted white.
 5. Product: Armstrong World Industries, Inc.; Suprafine ML Series.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION, GENERAL

- A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
1. Hangers shall be single lengths of wire without splices; coordinate lengths in deep ceiling cavities.
 2. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

3. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 4. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings 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 support ceiling loads within performance limits established by referenced standards and publications.
 5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 6. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 7. Exposed pop rivets for grid alignment purposes shall not be permitted.
- C. Suspension system shall be reinforced to support diffusers, light fixtures and any additional members. Install hanger wires to grid at each corner of light fixtures. Coordinate location with electrical and other trades.
1. Each individual fixture and attachment with combined weight of 56 pounds or less shall have two 12-gage wire hangers attached at diagonal corners of the fixture. These wires shall be slack. Fixtures and attachments with a combined weight of greater than 56 pounds shall be independently supported from the structure at all four corners.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. Arrange directionally patterned acoustical panels to run in the same direction.
 2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 4. Install hold-down clips in Vestibules and at areas indicated and in areas required by authorities having jurisdiction; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

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SECTION 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Resinous flooring system as shown on the drawings and in schedules.

1.3 SYSTEM DESCRIPTION

- A. The work shall consist of preparation of the substrate, the furnishing and application of a cementitious urethane based self-leveling seamless flooring system with quartz aggregate broadcast and Epoxy broadcast and topcoats.
- B. The system shall have the color and texture as specified by the Owner with a nominal thickness of 1/4 inch. It shall be applied to the prepared area(s) as defined in the plans strictly in accordance with the Manufacturer's recommendations.
- C. Cove base (if required) to be applied where noted on plans and per manufacturers standard details unless otherwise noted

1.4 SUBMITTALS

- A. Product Data: Latest edition of Manufacturer's literature including performance data and installation procedures.
- B. Manufacturer's Material Safety Data Sheet (MSDS) for each product being used.
- C. Samples: A 3 x 3 inch square sample of the proposed system. Color, texture, and thickness shall be representative of overall appearance of finished system subject to normal tolerances. Architect to select color from full range of manufacturer alternatives, samples to be submitted for selection.

1.5 QUALITY ASSURANCE

- A. The Manufacturer shall have a minimum of 10 years experience in the production, sales, and technical support of epoxy and urethane industrial flooring and related materials.
- B. The Applicator shall have experience in installation of the flooring system as confirmed by the manufacturer in all phases of surface preparation and application of the product specified.
- C. No requests for substitutions shall be considered that would change the generic type of the specified System.
- D. System shall be in compliance with requirements of United States Department of Agriculture (USDA), Food, Drug Administration (FDA), and local Health Department.
- E. System shall be in compliance with the Indoor Air Quality requirements of California section 01350 as verified by a qualified independent testing laboratory.
- F. A pre-installation conference shall be held between Applicator, General Contractor and the Owner to review and clarification of this specification, application procedure, quality control, inspection and acceptance criteria and production.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
 - 1. All components of the system shall be delivered to the site in the Manufacturer's packaging, clearly identified with the product type and batch number.
- B. Storage and Protection
 - 1. The Applicator shall be provided with a dry storage area for all components. The area shall be between 60 F and 85 F, dry, out of direct sunlight and in accordance with the Manufacturer's recommendations and relevant health and safety regulations.
 - 2. Copies of Material Safety Data Sheets (MSDS) for all components shall be kept on site for review by the Engineer or other personnel.
- C. Waste Disposal:
 - 1. The Applicator shall be provided with adequate disposal facilities for non-hazardous waste generated during installation of the system.

1.7 PROJECT CONDITIONS

- A. Site Requirements:
 - 1. Application may proceed while air, material and substrate temperatures are between 60 F and 85 F providing the substrate temperature is above the dew point. Outside of this range, the Manufacturer shall be consulted.
 - 2. The relative humidity in the specific location of the application shall be less than 85 % and the surface temperature shall be at least 5 F above the dew point.
 - 3. The Applicator shall ensure that adequate ventilation is available for the work area. This shall include the use of manufacturer's approved fans, smooth bore tubing and closure of the work area.

4. The Applicator shall be supplied with adequate lighting equal to the final lighting level during the preparation and installation of the system.
- B. Conditions of new concrete to be coated with cementitious urethane material:
1. Concrete shall be moisture cured for a minimum of 3 days and have fully cured a minimum of 5 days in accordance with ACI-308 prior to the application of the coating system pending moisture tests.
 2. Concrete shall have a flat rubbed finish, float or light steel trowel finish (a hard steel trowel finish is neither necessary nor desirable).
 3. Sealers and curing agents should not to be used.
 4. Concrete shall have a minimum design strength of 3.500 psi. and a maximum water/cement ratio of 0.45
 5. Concrete surfaces on grade shall have been constructed with a vapor barrier to protect against the effects of vapor transmission and possible delamination of the system.
- C. Safety Requirements:
1. All open flames and spark-producing equipment shall be removed from the work area prior to commencement of application.
 2. "No Smoking" signs shall be posted at the entrances to the work area.
 3. The Owner shall be responsible for the removal of foodstuffs from the work area.
 4. Non-related personnel in the work area shall be kept to a minimum.

1.8 WARRANTY

- A. Dur-A-Flex, Inc. warrants that material shipped to buyers at the time of shipment substantially free from material defects and will perform substantially to Dur-A-Flex, Inc. published literature if used in accordance with the latest prescribed procedures and prior to the expiration date.
- B. Dur-A-Flex, Inc. liability with respect to this warranty is strictly limited to the value of the material purchase.

PART 2 - PRODUCTS

2.1 FLOORING

- A. Dur-A-Flex, Inc, Hybri-Flex AC (self leveling broadcast colored chip), epoxy resin broadcast and aliphatic resinous topcoat seamless flooring system.
1. System Materials:
 - a. Topping: Dur-A-Flex, Inc, Poly-Crete SL resin, SL hardener and SL aggregate.
 - b. The colored chips shall be Dur-A-Flex, Inc. Macro or Micro colored chips.
 - c. Broadcast coat: Dur-A-Glaze #4 resin and hardener.
 - d. Topcoat: Dur-A-Flex, Inc. Accelera resin and hardener.
 1. Patch Materials
 - a. Shallow Fill and Patching: Use Dur-A-Flex, Inc. Poly-Crete MD (up to ¼ inch).
 - b. Deep Fill and Sloping Material (over ¼ inch): Use Dur-A-Flex, Inc. Poly-Crete WR.

2.2 MANUFACTURER

A. Dur-A-Flex, Inc., 95 Goodwin Street, East Hartford, CT 06108, Phone: (860) 528-9838, Fax: (860) 528-2802

B. Manufacturer of Approved System shall be single source and made in the USA.

2.3 PRODUCT REQUIREMENTS

A. Topping	Poly-Crete SL
1. Percent Reactive	100%
2. VOC	0 g/L
3. Bond Strength to Concrete ASTM D 4541	400 psi, substrates fails
4. Compressive Strength, ASTM C 579	9,000 psi
5. Tensile Strength, ASTM D 638	2,175 psi
6. Flexural Strength, ASTM D 790	5,076 psi
7. Impact Resistance @ 125 mils, MIL D-3134, No visible damage or deterioration	160 inch lbs
B. Broadcast Coat	Dur-A-Glaze #4
1. Percent Solids	100 %
2. VOC	3.8 g/L
3. Compressive Strength, ASTM D 695	11,200 psi
4. Tensile Strength, ASTM D 638	2,100 psi
5. Flexural Strength, ASTM D 790	5,100 psi
6. Abrasion Resistance, ASTM D 4060 C-10 Wheel, 1,000 gm load, 1,000 cycles	29 mg loss
7. Flame Spread/NFPA-101, ASTM E 84	Class A
8. Impact Resistance MIL D-24613	0.0007 inches, no cracking or delamination
9. Water Absorption. MIL D-24613	Nil
10. Potlife @ 70 F	20 minutes
C. Topcoat	Accelera
1. Percent Solids	100 %
2. VOC	0 g/L
3. Bond Strength to Concrete ASTM D 4541	400 psi, substrates fails
4. Hardness, Shore D ASTM D2240	70
5. Compressive Strength, ASTM C579	18,000 psi
6. Tensile Strength, ASTM D638	2,600 psi
7. Abrasion Resistance, ASTM D4060 C-17 Wheel, 1,000 gm load, 1,000 cycles	27 mg loss
8. Potlife @ 70 F	7 – 10 minutes
9. Gloss (ASTM D523) 60°	90
10. Coefficient of Friction (ASTM D2047)	0.8

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas and conditions, with Applicator present, for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting flooring performance.

1. Verify that substrates and conditions are satisfactory for flooring installation and comply with requirements specified.

3.2 PREPARATION

A. General

1. New and existing concrete surfaces shall be free of oil, grease, curing compounds, loose particles, moss, algae growth, laitance, friable matter, dirt, and bituminous products.
2. Moisture Testing: Perform tests recommended by manufacturer and as follows.
 - a. Perform anhydrous calcium chloride test ASTM F 1869-98. Application will proceed only when the vapor/moisture emission rates from the slab is less than and not higher than 20 lbs/1,000 sf/24 hrs.
 - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 99% relative humidity level measurement.
 - c. If the vapor drive exceeds 99% relative humidity or 20 lbs/1,000 sf/24 hrs then the Owner and/or Engineer shall be notified and advised of additional cost for the possible installation of a vapor mitigation system that has been approved by the manufacturer or other means to lower the value to the acceptable limit.
3. Mechanical surface preparation
 - a. Shot blast all surfaces to receive flooring system with a mobile steel shot, dust recycling machine (Blastrac or equal). All surface and embedded accumulations of paint, toppings hardened concrete layers, laitance, power trowel finishes and other similar surface characteristics shall be completely removed leaving a bare concrete surface having a minimum profile of CSP 4-5 as described by the International Concrete Repair Institute.
 - b. Floor areas inaccessible to the mobile blast machines shall be mechanically abraded to the same degree of cleanliness, soundness and profile using diamond grinders, needle guns, bush hammers, or other suitable equipment.
 - c. Where the perimeter of the substrate to be coated is not adjacent to a wall or curb, a minimum 1/4 inch key cut shall be made to properly seat the system, providing a smooth transition between areas. The detail cut shall also apply to drain perimeters and expansion joint edges.
 - d. Cracks and joints (non-moving) greater than 1/8 inch wide are to be chiseled or chipped-out and repaired per manufacturer's recommendations.
4. At spalled or worn areas, mechanically remove loose or delaminated concrete to a sound concrete and patch per manufacturer's recommendations.

3.3 APPLICATION

A. General:

1. The system shall be applied in five distinct steps as listed below:
 - a. Substrate preparation
 - b. Topping/overlay application with quartz aggregate broadcast.
 - c. Resin application with quartz aggregate broadcast.
 - d. Topcoat application
 - e. Second topcoat application.
 - f. Joint sealant application
 - g. Line Striping

2. Immediately prior to the application of any component of the system, the surface shall be dry and any remaining dust or loose particles shall be removed using a vacuum or clean, dry, oil-free compressed air.
 3. The handling, mixing and addition of components shall be performed in a safe manner to achieve the desired results in accordance with the Manufacturer's recommendations.
 4. The system shall follow the contour of the substrate unless pitching or other leveling work has been specified by the Architect.
 5. A neat finish with well-defined boundaries and straight edges shall be provided by the Applicator.
- B. Topping:
1. The topping shall be applied as a self-leveling system as specified by the Architect. The topping shall be applied in one lift with a nominal thickness of 1/8 inch.
 2. The topping shall be comprised of three components, a resin, hardener and filler as supplied by the Manufacturer.
 3. The hardener shall be added to the resin and thoroughly dispersed by suitably approved mechanical means. SL Aggregate shall then be added to the catalyzed mixture and mixed in a manner to achieve a homogenous blend.
 4. The topping shall be applied over horizontal surfaces using ½ inch “v” notched squeegee, trowels or other systems approved by the Manufacturer.
 5. Immediately upon placing, the topping shall be degassed with a loop roller.
 6. Quartz aggregate shall be broadcast to excess into the wet material at the rate of 0.8 lbs/sf.
 7. Allow material to fully cure. Vacuum, sweep and/or blow to remove all loose aggregate.
- C. Broadcast:
1. The broadcast coat resin shall be applied at the rate of 90 sf/gal.
 2. The broadcast coat shall be comprised of liquid components, combined at a ratio of 2 parts resin to 1 part hardener by volume and shall be thoroughly blended by mechanical means such as a high speed paddle mixer.
 3. Quartz aggregate shall be broadcast into the wet resin at the rate of 0.5 lbs/sf.
 4. Allow material to fully cure. Vacuum, sweep and/or blow to remove all loose aggregate.
- D. Topcoat:
1. The first pigmented topcoat shall be squeegee applied with a coverage rate of 90 sf/gal.
 2. The topcoat shall be comprised of liquid components, combined at a ratio of 2 parts resin to 1 part hardener by volume and shall be thoroughly blended by mechanical means such as a high speed paddle mixer.
 3. The first topcoat will be back rolled and cross rolled to provide a uniform texture and finish.
 4. The second pigmented topcoat (Armor-Top) shall be roller applied with a coverage rate of 500 sf/gal with duragrip.
 5. The finish floor will have a nominal thickness of 1/4 inch.
- E. Flexible Joint Sealant:
1. Apply a flexible urethane joint sealant in all construction and expansion joints according to manufacturers' guidelines of joint sealant.
- F. Line Striping:
1. Apply Dur-A-Gard with superstick additive for line striping as directed on the drawings.

3.4 FIELD QUALITY CONTROL

A. Tests, Inspection:

1. The following tests shall be conducted by the Applicator:
 - a. Temperature:
 - 1) Air, substrate temperatures and, if applicable, dew point.
 - b. Coverage Rates:
 - 1) Rates for all layers shall be monitored by checking quantity of material used against the area covered.

3.5 CLEANING AND PROTECTION

- A. Cure flooring material in compliance with manufacturer's directions, taking care to prevent their contamination during stages of application and prior to completion of the curing process.
- B. Remove masking. Perform detail cleaning at floor termination, to leave cleanable surface for subsequent work of other sections.

END OF SECTION 096723

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SECTION 099000 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exposed exterior items and surfaces with low VOC coatings complying with ME DEP regulations (OTC regulations).
 - 2. Exposed interior items and surfaces with low VOC coatings complying with ME DEP regulations (OTC regulations).
 - 3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Related Sections include the following:
 - 1. and frames.
 - 2. Division 09 Section "Gypsum Board Assemblies" for surface preparation of gypsum board.
 - 3. Division 32 Sections for traffic marking paint.
 - 4. Review all sections for shop primed items requiring field painting.

1.3 DEFINITIONS

- A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
 - 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 - 2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
 - 3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
 - 4. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.

5. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each paint system indicated. Include block fillers and primers.
 1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
 3. Include printed statement of VOC content for each product.
- C. Schedule: Provide schedule of all surfaces to be coated, with prime and finish coat material listed, and manufacturer's recommended wet film thickness.
- D. Samples: For each type of exposed finish required, submit color chips, 3- by 5-inches, matching colors indicated on Materials Legend.
- E. Manufacturer Certificates: Signed by manufacturers certifying that products with limit VOC amounts specified comply with requirements.
- F. Qualification Data: For Applicator.
- G. Color Mix Code: For all colors used for Project to include in Owner's Manual.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced Applicator who has completed painting system applications 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.
- B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.
- C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and substrate required. Duplicate finish of approved sample Submittals.
 1. Architect will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted.
 - a. Wall Surfaces: Provide samples of at least 100 sq. ft.
 - b. Small Areas and Items: Architect will designate items or areas required.
 2. After permanent lighting and other environmental services have been activated, apply benchmark samples, according to requirements for the completed Work. Provide required sheen, color, and texture on each surface.
 - a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
 3. Final approval of colors will be from benchmark samples.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Manufacturer's stock number and date of manufacture.
 - 4. Contents by volume, for pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
 - 8. VOC content.

- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 - 1. Protect from freezing. Keep storage area neat and orderly.
 - 2. Remove oily rags and waste daily.
 - 3. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 PROJECT CONDITIONS

- A. Apply finishes only when temperatures of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.
 - 1. At exterior applications, temperature shall be continuous for 48 hours prior to application, during application and for 48 hours after to application.

- B. Exterior Finishes: Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.
 - 2. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.

1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
 - 1. Quantity: Furnish Owner with not less than 1 gal., of each material and color applied for Owner's use during move in.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

- B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Benjamin Moore & Company (Moore).
 - 2. PPG Architectural Finishes, Inc. (PPG).
 - 3. Sherwin-Williams Co. (S-W).
 - 4. Flame Control Coatings, LLC (Flame Control); phone: (716) 282-1399; available through Sherwin-Williams.

2.2 COATINGS MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best quality coating material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers listed in the specification schedule. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
 - 2. Where schedule says no substitution, use proprietary product only. Do not propose substitution, as the products from the other manufacturers have been considered, and are not acceptable.
- C. VOC Compliance for Exterior and Interior Paints and Coatings: Provide the manufacturer's formulation for the products specified below that are VOC compliant with the State of Maine Department of Environmental Protection Regulation, "Chapter 151: Architectural and Industrial Maintenance (AIM) Coatings" and the following chemical restrictions from the Ozone Transport Commission (OTC) expressed in grams per liter:
 - 1. Flat Paints and Coatings: VOC content of not more than 100 g/L.
 - 2. Non-Flat Paints and Coatings: VOC content of not more than 150 g/L.
 - 3. Anticorrosive (Rust Preventative) Coatings: VOC content of not more than 400 g/L.
 - 4. Clear Wood Coatings:
 - a. Varnishes: VOC content of not more than 350 g/L.
 - 5. Fire Retardant Coatings:
 - a. Clear: VOC content of not more than 650 g/L.
 - b. Opaque: VOC content of not more than 350 g/L.
 - 6. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 - 7. Quick-Dry Enamels: VOC content of not more than 250 g/L.
 - 8. Quick-Dry Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 - 9. Specialty Primers, Sealers, and Undercoaters: VOC content of not more than 350 g/L.
 - 10. Stains: VOC content of not more than 500 g/L.
 - 11. Wood Preservatives: VOC content of not more than 350 g/L.
- D. Colors: Provide colors as indicated in Materials Legend; if color is not indicated, color shall be as selected by the Architect from the manufacturer's full range of options.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator and drywall subcontractor present, under which painting will be performed for compliance with paint application requirements.
 - 1. Inspect walls for dents and imperfections prior to painting. Inspect walls again after primer and first coat of paint applied, with Applicator and drywall subcontractor present. Drywall subcontractor shall touch-up as follows:
 - a. Touch-up visible gypsum board imperfections before priming of walls.
 - b. Touch-up imperfections found in field of boards and joints made visible from painting after first finish coat applied.
 - 2. If unacceptable conditions are encountered, prepare written report, endorsed by Applicator, listing conditions detrimental to performance of work.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 4. Application of coating indicates Applicator's acceptance of surfaces and conditions within a particular area.
 - 5. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of specified finish materials to ensure use of compatible primers.
 - 1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

- B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Provide barrier coats over incompatible primers or remove and reprime.
 - 2. Interior Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer.
 - b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including counters and paneling.

- c. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
 - d. If transparent finish is required, backprime with spar varnish.
 - 3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's standards.
 - a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - b. Touch up bare areas and shop-applied prime coats that have been damaged. Clean with solvents recommended by paint manufacturer and SSPC SP2; and touch up with same primer as the shop coat.
 - 4. Galvanized Surfaces: Uniformly abrade galvanized surfaces with a palm sander and 60 grit aluminum oxide so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
 - a. Clean field welds with nonpetroleum-based solvents complying with SSPC's standards so surface is free of oil and surface contaminants.
 - b. Coating shall be applied within 8 hours of sanding and wipe down.
 - 5. Metal Doors and Frames: Wipe down to remove oils and surface contaminants from shipping and installation.
 - a. Coating shall be applied within 8 hours of sanding and wipe down.
 - 6. PVC Trim: Clean surfaces of dirt, oil, and other foreign substances with mixture of water and mild detergent as recommended by manufacturer. Remove blemishes on surfaces exposed to view by sanding smooth and dust off.
- D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
 - 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces, unless indicated otherwise.
 9. Sand lightly between each succeeding enamel or varnish coat.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 2. Omit primer over metal surfaces that have been shop primed and touchup painted, unless otherwise indicated.
 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- C. Paint all exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.
1. Painting includes field painting of exposed bare and covered pipes and ducts (including color-coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment at all locations, except mechanical and electrical rooms.
- D. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
1. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- E. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions. Walls shall have roller finish.
1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

- F. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- G. Mechanical and Electrical Work: Painting of mechanical, plumbing, and electrical work is limited to items exposed in occupied spaces (outside mechanical and electrical rooms).
- H. Mechanical and plumbing items to be painted include, but are not limited to, the following:
 - 1. Piping, pipe hangers and supports.
 - 2. Heat exchangers.
 - 3. Ductwork, including interior of ductwork visible through air devices.
 - 4. Insulation.
 - 5. Accessory items.
- I. Electrical items to be painted include, but are not limited to, the following:
 - 1. Conduit and fittings.
 - 2. Panelboards.
- J. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- K. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- L. Transparent (Clear or Stained) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
 - 1. Provide satin finish for final coats, unless otherwise noted.
- M. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
- N. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- O. Exterior Ferrous Metal Items to Be Painted Include, but Are Not Limited To, the Following:
 - 1. Steel doors and frames.
 - 2. Bollards.
 - 3. Miscellaneous metal items, including galvanized steel.
- P. Interior Ferrous Metal Items to Be Painted Include, but Are Not Limited To, the Following:
 - 1. Steel doors and frames.
 - 2. Handrails.
 - 3. Access panels (both sides).

3.4 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the Project site.
 - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.
- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINT SCHEDULE

- A. VOC Compliance, General: Provide the manufacturers' formulations for the products specified below that comply with the VOC requirements for the State of Maine Department of Environmental Protection in paragraph 2.2.C of this Section.
- B. Exposed Heavy Timber Framing, Transparent Finish: Finish provided by fabricator/installer.
- C. Wood Soffits and Ceilings, Transparent (Pickled) Finish: Finish provided by fabricator/installer.
- D. Fiber-Cement Siding: Provide the following finish systems over exterior fiber-cement substrates:
 - 1. Low-Luster Acrylic Finish: 1 finish top coat over factory-applied sealer/primer and intermediate coat.
 - a. Sealer/Primer: Factory applied.
 - b. Intermediate Coat: Factory applied.
 - c. First Topcoat: Low-luster (low lustre or satin), exterior, 100 percent acrylic-latex coating applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product. Apply one coat of finish on flashing materials before they are installed, and topcoat with siding topcoat application. Touch up all surface fasteners with one coat of finish before application of topcoat.
 - 1) Moore: Aura Waterborne Exterior Paint - Low Lustre Finish No. 634; 2.4 mils DFT.
 - 2) PPG: Speedhide 6-2045XI Exterior Satin 100% Acrylic Latex Satin; 1.4 mils DFT.
 - 3) S-W: Duration Exterior Acrylic Satin K33-200 Series; 2.4 mils DFT.
- E. PVC Trim: Provide the following finish systems over exterior PVC substrates:
 - 1. Low-Luster Acrylic Finish: 2 finish coats over a prime coat.

- a. Prime Coat: Exterior, latex primer/sealer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Fresh Start Multi-Purpose Latex Primer N023; 1.2 mils DFT.
 - 2) PPG: Speedhide 6-609 Exterior Latex Wood Primer; 1.6 mils DFT.
 - 3) SW: Multi-Purpose Interior/Exterior Latex Primer/Sealer B51-450 Series; 1.4 mils DFT.
 - b. First and Second Coats: Low-sheen (satin), exterior, acrylic-latex paint, tinted with vinyl safe colorants, paint applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Aura Waterborne Exterior Paint Satin Finish No. 631 with Gennex colorant system; 2.4 mils DFT per coat.
 - 2) PPG: Speedhide 6-2045XI Exterior 100% Acrylic Latex Satin with SidingSafe Color Technology colorants; 1.4 mils DFT per coat.
 - 3) S-W: Duration Exterior Latex Satin K33-200 Series with vinyl safe colorants; 2.5 mils DFT per coat.
- F. Ferrous and Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated (galvanized) metal surfaces. Primer is not required on shop-primed items, except zinc-coated (galvanized) steel doors and frames, which require a primer under this specification.
- 1. Semigloss, Waterborne Alkyd Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, corrosion resistant, single component, acrylic-modified alkyd metal primer applied to galvanized metals not previously shop-primed applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product. Moore and S-W do not have exterior products meeting requirements.
 - 1) PPG: Speedhide 6-209 Interior/Exterior Galvanized Steel Primer; 1.8 mils DFT.
 - b. First and Second Coats: Semigloss, exterior, single component, waterborne alkyd applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product. Moore does not have exterior products meeting requirements; S-W ProMar 200 Interior Waterbased Acrylic-Alkyd not approved for exterior use.
 - 1) PPG: Speedhide Interior/Exterior WB Alkyd Semi-Gloss 6-1510 Series; 1.5 mils DFT per coat.

3.7 LOW VOC INTERIOR COATINGS

- A. VOC Compliance, General: Provide the manufacturers' formulations for the products specified below that comply with the VOC requirements for the State of Maine Department of Environmental Protection in as defined in paragraph 2.2.C of this Section.
- B. Gypsum Board: Provide the following finish systems over interior gypsum board and tackable wall surfaces:
 - 1. Flat Acrylic Finish, GPDW Soffits and Ceilings: 2 finish coats over a primer.
 - a. Primer: Low-odor, low or zero VOC, latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Interior Latex Primer No. N534; 1.8 mils DFT.

- 2) PPG: Speedhide Interior MaxPrime Latex Primer/Surfacer 6-4; 1.0 mils DFT.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer B28W02600 Series; 1.0 mils DFT.
 - b. First and Second Coats: Low-odor, low or zero VOC, flat, acrylic-latex-based, interior paint applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Interior Flat Finish No. N536; 1.8 mils DFT per coat.
 - 2) PPG: Speedhide Interior Latex Flat 6-70 Series; 1.3 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Flat, B30W2600 Series; 1.6 mils DFT per coat.
2. Low-Luster (Satin or Eggshell), Acrylic-Latex Finish; Walls: 2 finish coats over a primer.
- a. Primer: Low odor, low or zero VOC, latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Interior Latex Primer No. N534; 1.8 mils DFT.
 - 2) PPG: Speedhide Interior MaxPrime Latex Primer/Surfacer 6-4; 1.0 mils DFT.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer, B28W02600 Series; 1.0 mils DFT.
 - b. First and Second Coats: Low odor, low or zero VOC, low-luster (eggshell or satin), acrylic-latex, interior finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Low Sheen Finish No. N537; 1.8 mils DFT per coat.
 - 2) PPG: Speedhide Interior Satin Acrylic Latex, Series 6-3511; 1.3 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Eg-Shel, B20W2600 Series; 1.7 mils DFT per coat.
- C. Natural-Finish Woodwork: Provide the following finishes over new, interior woodwork:
- 1. Waterborne, Satin Polyurethane Finish: 3 finish coats of a waterborne, clear-satin polyurethane.
 - a. First, Second and Third Finish Coats: Waterborne, polyurethane finish applied at spreading rate recommended by the manufacturer.
 - 1) Moore: Benwood Stays Clear Acrylic Polyurethane Low Lustre No. 423.
 - 2) PPG: Olympic 42786 Premium Interior Water Based Polyurethane Satin Clear.
 - 3) S-W: Minwax Polycrylic Protective Finish Satin Clear.
- D. Stained Woodwork and Trim, (Including Interior Frame and Sash of Clad Wood Windows): Provide the following stained finishes over new, interior woodwork and trim:
- 1. Waterborne, Satin Polyurethane Finish: 3 finish coats of a waterborne, clear-satin polyurethane over a stain coat.
 - a. Stain Coat: VOC compliant, penetrating, interior wood stain applied at spreading rate recommended by the manufacturer.
 - 1) Moore: Benwood Interior Wood Finishes Waterborne Stain No. 205.
 - 2) PPG: Olympic 44500 Premium Interior Oil Based Wood Stain.

- 3) S-W: Minwax Wood Finish VOC Formula.
 - b. First, Second and Third Finish Coats: Waterborne, polyurethane finish applied at spreading rate recommended by the manufacturer.
 - 1) Moore: Benwood Stays Clear Acrylic Polyurethane Low Lustre No. 423.
 - 2) PPG: Olympic 42786 Premium Interior Water Based Polyurethane Satin Clear.
 - 3) S-W: Minwax Polycrylic Protective Finish Satin Clear.
- E. Ferrous Metal: Provide the following finish systems over ferrous metal. Primer is not required on shop-primed items, except steel doors and frames, which require a primer under this specification. Prime bare spots and cracks on other ferrous metals.
- 1. Semigloss, Waterborne Alkyd Finish or Waterborne Alkyd Urethane Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, corrosion resistant, single component, acrylic-modified alkyd primer or self cross-linking acrylic primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Advance Waterborne Interior Alkyd Primer No. 790; 1.6 mils DFT.
 - 2) PPG: Pitt-Tech Plus 90-912 Interior/Exterior Industrial DTM Primer; 3.0 mils DFT.
 - 3) S-W: Pro Industrial Pro-Cryl Universal Primer B66-310 Series; 3.0 mils DFT.
 - b. First and Second Coats: Low VOC, semigloss, waterborne alkyd interior or waterborne alkyd urethane finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Advance Waterborne Interior Alkyd Semi-Gloss No. 793; 1.3 mils DFT per coat.
 - 2) PPG: Speedhide Interior/Exterior WBAlkyd Semi-Gloss No. 6-1510 Series; 1.5 mils DFT per coat.
 - 3) S-W: Pro Industrial Waterbased Alkyd Urethane Enamel B53-1150 Series; 1.5 mils DFT per coat.
- F. Zinc-Coated Metal: Provide the following finish systems over zinc-coated metal. Primer is not required on shop-primed items, except zinc-coated steel doors and frames, which require a primer under this specification. Prime bare spots and cracks on zinc-coated metals.
- 1. Semigloss, Waterborne Alkyd Finish or Waterborne Alkyd Urethane Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, corrosion resistant, single component, acrylic-modified alkyd primer or self cross-linking acrylic primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Advance Waterborne Interior Alkyd Primer No. 790; 1.6 mils DFT.
 - 2) PPG: Speedhide 6-209 Interior/Exterior Galvanized Steel Primer; 3.6 mils DFT.
 - 3) S-W: Pro Industrial Pro-Cryl Universal Primer B66-310 Series; 3.0 mils DFT.
 - b. First and Second Coats: Low VOC, semigloss, waterborne alkyd interior or waterborne alkyd urethane finish applied at spreading rate recommended by the

manufacturer to achieve a dry film thickness per coat of not less than indicated for product.

- 1) Moore: Advance Waterborne Interior Alkyd Gloss No. 794; 1.6 mils DFT per coat.
- 2) PPG: Speedhide Interior/Exterior WBAlkyd Semi-Gloss No. 6-1510 Series; 1.5 mils DFT per coat.
- 3) S-W: Pro Industrial Waterbased Alkyd Urethane Enamel B53-1150 Series; 1.5 mils DFT per coat.

G. Telecommunication, Data and Electrical Backboards: Provide the following finish over plywood:

1. Flat Intumescent Finish: Two finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Fresh Start High-Hiding All-Purpose Primer No. 056; 1.4 mils DFT.
 - 2) SW: Preprite Problock Interior/Exterior Latex Primer\Sealer; 1.4 mils DFT.
 - b. First and Second Coats: Intumescent-type, fire-retardant paint applied at spreading rate recommended by manufacturer to achieve a total dry film thickness of not less than 4 mils; white color for telecommunication and black for electrical.
 - 1) Moore: P59 220 Latex Fire-Retardant Coating.
 - 2) FlameControl: 20-20A Flat Latex Intumescent Coating.

H. Smoke and Fire-Rated Partition Identification: Identify all smoke partitions and all fire-rated walls and partitions by stenciling "X-HOUR FIRE WALL", where "X" is the hourly rating; provide on each side of rated walls above ceiling line with 4 inch high letters in red or orange semigloss paint; each rated wall shall be identified with fire rating of wall at least once and at a spacing not greater than 12 feet o.c. and not more than 5 feet from each end of the wall. Identify all smoke barriers and partitions by stenciling "SMOKE" on each side of walls above ceiling line with 4 inch high letters in bright green semigloss paint; each rated wall shall be identified at least once and at a spacing not greater than 12 feet o.c. and not more than 5 feet from each end of wall.

1. First Coat: Low odor, low or zero VOC, semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - a. Moore: Ultra Spec 500 Semi-Gloss No. N539; 1.8 mils DFT.
 - b. PPG: Speedhide Interior High Lustre Semi-Gloss Latex, 6-8510 Series; 1.2 mils DFT.
 - c. S-W: ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series; 1.6 mils DFT.

END OF SECTION 099000

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SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Markerboards.
 - a. Markerboard writing surfaces.
 - b. Tackboards.
- B. Related Sections:
 - 1. Division 06 for custom wood trimmed, paintable tack surfaces (Homosote) and fabric covered bulletin boards.
 - 2. Division 09 Section "Gypsum Board Assemblies" for concealed flat metal strap, 18 gage, required for installation of boards.

1.3 DEFINITIONS

- A. Tackboard: Framed or unframed, tackable, visual display board assembly.
- B. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes chalkboards, markerboards, and tackboards.
- C. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of chalkboards, markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, installation, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces. Include manufacturer's written installation instructions.
- B. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of panel joints.
 - 2. Show locations of special-purpose graphics for visual display surfaces.
 - 3. Include sections of typical trim members.
- C. Product Schedule: For visual display surfaces. Use same room designations indicated on Drawings.
 - 1. Identify size and locations of markerboards for projection, and markerboard writing surfaces with map rails.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For visual display surfaces to include in maintenance manuals. Include data on regular cleaning, stain removal, and precautions.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain all visual display surfaces from single source from single manufacturer.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-built visual display surfaces, including factory-applied trim and factory applied z-bar hangers where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
- B. Store visual display surfaces in accordance with manufacturer's requirements.
- C. Store visual display surfaces vertically with packing materials between each unit.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings 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. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.

1.9 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 - 2. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Porcelain-Enamel Face Sheet: Manufactured in accordance with Porcelain Enamel Institute's specification. 0.024-inch- thick (24 gage) enameling-grade steel with exposed face 3-coat finish process, 1.5-to-2.2-mil- thick bottom ground coat, 2.0-to-2.8-mil- thick top ground coat and 3.0-to-4.0-mil- thick top cover (color) coat.
 - 1. Firing Temperature: Enamel shall be fired at lowest possible temperatures to reduce steel and porcelain stresses and achieve superior enamel and hardness.
 - a. Surface: LCS³ No. 100 Satin Gloss, White; Claridge Products and Equipment.
- B. Core Material: Medium Density Fiberboard (MDF); ANSI A208.2, Grade 130; not less than 7/16-inch thick.
- C. Extruded Aluminum Trim: 6063 alloy grade aluminum with T5 tempering in accordance with ASTM B221, and shall have 201-R1 satin anodize finish.

2.2 MARKERBOARD ASSEMBLIES

- A. Projection Porcelain-Enamel Markerboards, MBP5: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of steel backing sheet, MDF core material, porcelain-enamel face sheet with satin-gloss finish; dry-erase markers wipe clean with dry cloth or standard eraser.
 - 1. Face Sheet: Projection porcelain-enamel satin gloss finish suitable for use as projection surface.
 - a. Color: Claridge White LCS³ No. 100.
 - 2. Backing: Not less than 7/16 inch thick; with minimum 0.013-inch- thick, steel sheet stiffener backing to improve flatness for interactive short throw projection.
 - 3. Trim: 5/8-inch wide face trim at top and sides.
 - 4. Accessories: Continuous chalk tray full length of board.
 - 5. Mounting: Factory applied continuous Z-Bar hangers to provide flatter projection surface.
 - 6. Panel Size: 5 foot height by indicated widths.
 - 7. Product: Basis of Design, Aspire Series with accessories specified; Claridge Products and Equipment.
- B. Porcelain-Enamel Markerboards, MB5: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of steel backing sheet, MDF core material, porcelain-enamel face sheet with satin-gloss finish; dry-erase markers wipe clean with dry cloth or standard eraser.
 - 1. Face Sheet: Porcelain-enamel satin gloss finish. Shall match adjacent MBP5 surface.
 - a. Color: Claridge White LCS³ No. 100.
 - 2. Backing: Not less than 7/16 inch thick; with moisture backing.
 - 3. Mounting: Factory applied continuous Z-Bar hangers to align markerboard with adjacent MB5P projection board.
 - 4. Trim: 5/8-inch wide face trim, factory applied.
 - 5. Accessories: Factory applied.
 - a. Continuous chalk tray full length of board.
 - 6. Panel Size: 5 foot height by indicated widths.

7. Product: Basis of Design, Series 4 with accessories specified; Claridge Products and Equipment.
- C. Porcelain-Enamel Markerboards, MBS: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of steel backing sheet, MDF core material, porcelain-enamel face sheet with satin-gloss finish; dry-erase markers wipe clean with dry cloth or standard eraser.
1. Face Sheet: Porcelain-enamel satin gloss finish with music staff lines.
 - a. Color: Claridge White LCS³ No. 100.
 2. Backing: Not less than 7/16 inch thick; with moisture backing.
 3. Mounting: Factory applied continuous Z-Bar hangers to align markerboard with adjacent MB5P projection board.
 4. Trim: 5/8-inch wide face trim, factory applied.
 5. Accessories: Factory applied.
 - a. Continuous chalk tray full length of board.
 6. Panel Size: 4 foot height by indicated widths.
 7. Product: Basis of Design, Series 4 with accessories specified; Claridge Products and Equipment.
- D. Porcelain-Enamel Markerboards, MB8: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of steel backing sheet, MDF core material, porcelain-enamel face sheet with satin-gloss finish; dry-erase markers wipe clean with dry cloth or standard eraser.
1. Face Sheet: Porcelain-enamel satin gloss or gloss finish.
 - a. Color: Claridge White LCS³ No. 100.
 2. Backing: Not less than 7/16 inch thick; with moisture backing.
 3. Mounting: Clips and adhesive mounting system.
 4. Trim: 5/8-inch wide face trim, factory applied.
 5. Accessories: Factory applied.
 - a. Continuous chalk tray full length of board.
 6. Panel Size: 4 foot height by indicated widths.
 7. Product: Basis of Design, Series 4 with accessories specified; Claridge Products and Equipment.

2.3 FABRIC WRAPPED TACKBOARD ASSEMBLIES

- A. Basis-of-Design: Subject to compliance with requirements, provide 800 Series CO, by Claridge Products and Equipment, Inc. or comparable products from one of the following:
1. K-Pro Specialty Products.
 2. AARCO Products, Inc.
- B. Polyester-Fabric-Faced Tackboard, FWT1: 1/4-inch- thick, polyester-fabric-faced cork sheet factory laminated to 1/4-inch- thick hardboard or plywood backing.
1. Fabric Surface-Burning Characteristics: Comply with ASTM E 84, Class A; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 2. Fabric Color: As selected by Architect from manufacturer's full range of standard options.
- C. Aluminum Frame: Shall match frame used for markerboards and natural cork tackboards.

2.4 MARKERBOARD ACCESSORIES

- A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; standard size and shape.
 - 1. Factory-Applied Trim: Manufacturer's standard of size indicated with no visible screw or exposed joints.
- B. Chalk Tray: Manufacturer's standard, continuous blade-type.
 - 1. Solid Type: Extruded aluminum with ribbed section and injection molded end closures.
- C. Mounting Hardware: Manufacturer's standard continuous Z-Bar hangers, factory applied to back of boards; provide for MBP5, MB5, MBS markerboards.
- D. Special-Purpose Graphics: Fuse or paint the following graphics into surface of porcelain-enamel visual display unit:
 - 1. Music staff lines. Provide at locations indicated.

2.5 FABRICATION

- A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
- B. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.
 - 1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
- C. Aluminum Frames and Trim for Markerboards and Tackboards: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
 - 1. Trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class 2, 0.4 mil to 0.7 mil coating thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation and backing and blocking for visual display surfaces.
- C. If unacceptable conditions are encountered, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - 1. Failure to report defects, if any, will be construed as acceptance of work as executed and will not release those responsible for faulty workmanship.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.

3.3 INSTALLATION, GENERAL

- A. General: Install in accordance with manufacturer's written installation instructions. Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES WITH Z-BAR HANGERS

- A. General: Mount visual display boards in accordance with manufacturer's written requirements for marker boards with continuous Z-bar mounting hangers.
- B. Visual Display Boards (Projection): Attach concealed, continuous Z-bar hangers to wall surfaces with fasteners at not more than 16 inches o.c. Install continuous Z-bar hangers at top, mid-point and bottom locations as directed by manufacturer's written instructions to properly align with board mounted Z-bars. When installing boards on wall hangers, make sure that wall hangers have properly engaged with hangers on boards.
 - 1. Z-bar hangers shall be level and plumb before final fastening to wall. Verify flatness of the wall with level and straightedge. Shim as required along the length of the wall mounted Z-bar hangers so boards are flat and uniform, free of distortion that would affect overhead short throw projection. Board z-bars shall set into wall Z-bar hangers tight and uniform, free of board movement and rattle when pressure is applied to face of boards.
 - 2. Attach chalk trays to boards with fasteners at not more than 12 inches o.c.

3.5 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES WITH CLIPS AND ADHESIVE

- A. General, MB8 Boards: Mount visual display boards in accordance with manufacturer's written requirements for marker boards with clips and adhesive.
- B. Visual Display Boards: Attach visual display boards to wall surfaces with egg-size adhesive gobs placed horizontally and vertically at spacing required by manufacturer.
- C. Secure both top and bottom of boards to walls.
 - 1. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than 24 inches o.c.
 - a. Attach chalk trays to boards with fasteners at not more than 12 inches o.c.

3.6 CLEANING AND PROTECTION

- A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
- B. Remove and replace visual display assemblies that are damaged or do not comply with requirements.

END OF SECTION 101100

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SECTION 108500 - BUILDING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Residential Appliances.
 - 2. Storage Shelving.
 - 3. Demonstration Mirror.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for concealed blocking required to install building specialties.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittals Procedures."
- B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and method of attachment for each product indicated.
- C. Samples: For each product involving a color selection, submit the manufacturer's color charts showing the full range of colors and patterns available.
- D. Maintenance Data: For all items to include in Operating and Maintenance Manuals.

1.4 WORKMANSHIP

- A. Work of this Section shall be executed in strict accordance with Drawings, approved Shop Drawings and approved samples.
- B. Insofar as possible, fitting, construction and fabrication of the work shall be executed at shops, ready for delivery and erection at buildings.
- C. Provide all holes, connections, and fastenings for and to work of other trades abutting, adjoining, or intersecting work of this Section.

PART 2 - PRODUCTS

2.1 RESIDENTIAL APPLIANCES

- A. Dishwasher: Complying with AHAM DW-1 and ASSE 1006.
1. Product: GE Appliances; Model GLDA696PSS.
 2. Type: Built-in undercounter; ADA compliant.
 3. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.
 4. Sound Level: Maximum 56 dB.
 5. Tub and Door Liner: Stainless steel with sealed detergent and automatic rinsing-aid dispensers.
 6. Rack System: PVC-coated sliding dish racks, with removable cutlery basket.
 7. Controls: Touch-pad controls with four wash cycles and hot-air and heat-off drying cycle options.
 8. Appliance Color/Finish: Stainless steel.

2.2 STORAGE SHELIVING

Description: Shelving Unit

Manufacturer: Cambro

Model #: Elements Series

SIS #: T037

Quantity: 7

Specification:

Each unit to be a 4-Shelf Cambro Elements Series Starter Stationary Unit with the following features: Shelf Plates only with Camguard antimicrobial. 3 Post Heights 64", 72", 84". 3 Shelf Widths 18", 21", 24". 5 Shelf Lengths 36", 42", 48", 54", 60".

Each Starter Unit shall include: 4 stationary posts with leveling feet installed pre-assembled with post connectors and wedges, 1 bag of 32 stationary traverse dovetails (16 ea. A and B), Vented shelf plates (for 4 shelves), 8 stationary traverses and instructions.

Posts: Proprietary non-corrosive composite material. Post Connectors: Glass Filled Polypropylene. Traverses: Proprietary non-corrosive composite material. Vented/Solid Shelf Plates: Reinforced polypropylene with Camguard antimicrobial. Corner Connectors: Glass Filled Polypropylene. Adjustable Foot: Glass Filled Nylon. Seismic Foot: Stainless Steel post and wide foot plate, 3 holes for bolts. (Bolts not provided) Divider Bars: Glass Filled Nylon. Wall Fastener: Stainless Steel. Dovetails: Resin Nylon Wedges: Resin Polypropylene

(1) One unit at 21" x 48" x 72" high. (Model # ESU214872V4)

(1) One unit at 21" x 54" x 72" high. (Model # ESU215472V4)

(6) Six units at 21" x 60" x 72" high. (Model # ESU216072V4)

2.3 DEMONSTRATION MIRROR

- A. Hann Manufacturing, Inc., PO Box 400, Malta, OH 43758, (740) 962-4885
1. Model DM-2448, for a 30" x 60" surface.

2.4 FABRICATION

- A. General: Materials shall be free from defects impairing strength, durability or appearance.

- B. Sections and shapes shall be rolled, formed, drawn or extruded as required for respective functions.
- C. Fastenings, exposed metal fastenings, and accessories, unless Underwriters' prohibit for safety, shall be of same materials, texture, color and finish as the base metal to which applied.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installers present, for compliance with requirements for installation tolerances, and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. All items specified under this Section shall be installed in strict accordance with manufacturer's recommendations and approved Shop Drawings.

3.3 CLEANING AND PROTECTION

- A. Clean building specialties in accordance with manufacturer's instructions. Touch up factory- applied finishes to restore damaged or soiled areas.
- B. Provide final protection and maintain conditions that ensure building specialties are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 108500

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SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Manually operated roller shades with single rollers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches long.
- D. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of shadeband material, signed by product manufacturer.
- C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.9 WARRANTY

- A. Roller Shade Hardware and Chain: Manufacturer's standard non-depreciating twenty-five year limited warranty.
- B. Shade Cloth: Standard non-depreciating 10-year limited warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Draper Inc.; Manual Clutch Operated Flex Shade.
 - 2. Mecho Shade Systems; Mecho/5 System.
- B. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Nickel-plated metal.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Clip, jamb mount.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: Right side of inside face of shade.
 2. Direction of Shadeband Roll: Regular, from back of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Shadebands:
1. Shadeband Material: Light-filtering fabric and light-blocking fabric where indicated.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
 - b. Color and Finish: As selected by Architect from manufacturer's full range.
- F. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 3 inches.
 2. Endcap Covers: To cover exposed endcaps.
 3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric for Chain-and-Clutch Roller Shades: Woven fabric, stain and fade resistant.
1. Source: Roller-shade manufacturer.
 2. Type: PVC-coated polyester.
 3. Weave: Basketweave.
 4. Orientation on Shadeband: Up the bolt.
 5. Openness Factor: 5 percent.
 6. Color: As selected by Architect from manufacturer's full range.
 7. Product: Mecho Shade Systems; ThermoVeil Dense Basket Weave, 1500 Series or equal for Draper Inc.
 8. Location: For outer shade for manually operated chain-and-clutch roller shades with double rollers.

2.4 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
 - 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
 - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
 - 2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 SCHEDULE

- A. Light-Filtering Shades: Provide in Classroom 104.

END OF SECTION 122413

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SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The fire protection system shall be installed in accordance with the 2016 edition of NFPA 13.
- B. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Escutcheons.
 - 3. Equipment installation requirements common to equipment sections.

1.3 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. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- D. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Mechanical sleeve seals.
 - 2. Escutcheons.

1.5 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.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. 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 (3.2-mm) 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.
 - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.4 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.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated or white painted in finished spaces.
- D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

PART 3 - EXECUTION

3.1 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 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. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - c. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - e. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. 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 "Joint Sealants" for materials and installation.
- K. 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 "Penetration Firestopping" for materials.
- L. Verify final equipment locations for roughing-in.

- M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 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. 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.
- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PAINTING

- A. Painting of fire-suppression systems, equipment, and components exposed in finished spaces is specified in Division 09 Section "Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 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.

END OF SECTION 210500

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Sprinklers.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. 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.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventer.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Classrooms, Offices and Public Areas: Light Hazard.
 - 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m.)
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - 4. Maximum Protection Area per Sprinkler:
 - a. Classrooms, Offices and Public Areas: 225 sq. ft. (20.9 sq. m.)
 - b. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Domestic water piping.
 - 2. HVAC Ductwork.
 - 3. HVAC hydronic piping.
 - 4. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - 5. Structural framing components.
- E. Qualification Data: For qualified Installer.
- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 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 Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 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. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and 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 used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Pipe ends may be factory or field formed to match joining method.
- B. Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- C. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- D. Cast-Iron Flanges: ASME 16.1, Class 125.
- E. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Victaulic Company.
 - 2. Pressure Rating: 175 psig (1200 kPa minimum).
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
- B. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. Victaulic Company.
 - 3. Standard: UL 1091 except with ball instead of disc.
 - 4. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
 - 5. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 6. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.
- C. Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. Anvil International, Inc.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Division.
 - f. Globe Fire Sprinkler Corporation.
 - g. Kennedy Valve; a division of McWane, Inc.
 - h. Metraflex, Inc.
 - i. Milwaukee Valve Company.
 - j. Mueller Co.; Water Products Division.
 - k. NIBCO INC.
 - l. Potter Roemer.
 - m. Reliable Automatic Sprinkler Co., Inc.
 - n. Tyco Fire & Building Products LP.
 - o. United Brass Works, Inc.
 - p. Victaulic Company.
 - q. Viking Corporation.
 - r. Watts Water Technologies, Inc.

3. Standard: UL 312.
4. Pressure Rating: 250 psig (1725 kPa) minimum 300 psig (2070 kPa).
5. Type: Swing check.
6. Body Material: Cast iron.
7. End Connections: Flanged or grooved.

D. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Fire Protection Products, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Tyco Fire & Building Products LP.
 - i. Victaulic Company.
 - j. Watts Water Technologies, Inc.

E. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. AFAC Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
3. Standard: UL 1726.
4. Pressure Rating: 175 psig (1200 kPa) minimum.
5. Type: Automatic draining, ball check.
6. Size: NPS 3/4 (DN 20).
7. End Connections: Threaded.

2.5 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Reliable Automatic Sprinkler Co., Inc.
 2. Tyco Fire & Building Products LP.
 3. Victaulic Company.
 4. Viking Corporation.
- B. General Requirements:
 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:

1. Acoustical Tile Ceilings: White Semi-recessed sprinklers.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Acoustical Tile Ceiling Mounting: White Semi-recessed sprinklers.
- 2.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
4. Standard: UL 199.

2.6 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Stamped Steel or Plastic Split Escutcheons: Polished chrome-plated or white painted finish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

- A. 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.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

- C. Use listed 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 (DN 50) and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- F. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- G. Fill sprinkler system piping with water.

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. 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.
- H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

3.4 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 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. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.5 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in the center of acoustical ceiling panels.

3.6 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 1. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated or white painted finish.
 2. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated or white painted finish.
 3. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
 4. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Leak Test: After installation, charge systems 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. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 4. Energize circuits to electrical equipment and devices.

5. Coordinate with fire-alarm tests. Operate as required.
 6. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the system.

3.11 PIPING SCHEDULE

- A. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) shall be one of the following:
1. Standard-weight, black-steel pipe with cut grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
1. Standard-weight black-steel pipe with cut grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms with Suspended Acoustical Tile Ceilings: Semi Recessed type sprinklers.
 - 2. Hard ceilings (gypsum) and soffits: Semi Recessed type sprinklers.

- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Semi Recessed Sprinklers: White, with two-piece white escutcheon.
 - 2. White ceilings suspended or hard: Factory painted white semi recessed type.

END OF SECTION 211313

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 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:
 - 1. Division 23 Section "Common Work Results for HVAC."

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Escutcheons.
 - 5. Equipment installation requirements common to equipment sections.
 - 6. Painting and finishing.
 - 7. Supports and anchorages.
- B. The plumbing contractor is responsible for obtaining the plumbing permit for the project.

1.3 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. The following are industry abbreviations for plastic materials:
 - a. ABS: Acrylonitrile-butadiene-styrene plastic.
 - b. CPVC: Chlorinated polyvinyl chloride plastic.
 - c. PVC: Polyvinyl chloride plastic.

- F. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Mechanical sleeve seals.
 - 3. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. 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.

1.6 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.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

1.8 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
- B. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

1.9 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

1.10 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

1.11 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.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 - 2. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
 - 3. Aboveground Pressure Piping: Pipe fitting.
- B. Flexible Transition Couplings for Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

1.12 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, 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 (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.

- b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- 1. Available Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- 1. Available Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

1.13 SLEEVES

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- B. PVC Pipe: ASTM D 1785, Schedule 40.

1.14 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.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

PART 2 - EXECUTION

2.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 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 within 18" of the ceiling 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 escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
- M. 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 for materials.
- N. Verify final equipment locations for roughing-in.
- O. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

2.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 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. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Non-pressure Piping: Join according to ASTM D 2855.

2.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2.4 EQUIPMENT 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.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 220500

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermometers.
 - 2. Gages.
 - 3. Test plugs.
- B. Related Sections:
 - 1. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters outside the building.
 - 2. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.

PART 2 - PRODUCTS

2.1 DIRECT-MOUNTING, LIQUID ACTUATED DIAL THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements., provide products by one of the following
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Terice, H.O. Co. or comparable product by one of the following:
 - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 2. KOBOLD Instruments, Inc.
 - 3. Marsh Bellofram.
 - 4. Terice, H. O. Co.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

- C. Case: Dry type, cast aluminum metal, 6-inch (152-mm) diameter.
- D. Element: Bourdon tube or other type of pressure element.
- E. Movement: Mechanical, connecting element and pointer.
- F. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- G. Pointer: Black metal.
- H. Window: Glass.
- I. Ring: Metal.
- J. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- K. Thermal System: Liquid activated.
- L. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Terice H.O., Co. or comparable product by one of the following:
 1. AMETEK, Inc.; U.S. Gauge Div.
 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 3. Palmer - Wahl Instruments Inc.
 4. Terice, H. O. Co.
 5. Weiss Instruments, Inc.
 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- C. Manufacturers: Same as manufacturer of thermometer being used.
- D. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Terice H.O. Co. product indicated on Drawings or comparable product by one of the following:
 1. AMETEK, Inc.; U.S. Gauge Div.
 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 3. Palmer - Wahl Instruments Inc.
 4. Terice, H. O. Co.

5. Weiss Instruments, Inc.
 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- C. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
1. Case: Dry type, drawn steel or cast aluminum, 6-inch (152-mm) diameter.
 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 3. Pressure Connection: Brass, NPS 1/4 (DN 8), 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, non-reflective aluminum with permanently etched scale markings.
 6. Pointer: Red or other dark-color metal.
 7. Window: Glass or plastic.
 8. Ring: Metal, Brass or Stainless steel.
 9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
 10. Range for Fluids under Pressure: Two times operating pressure.
- D. Pressure-Gage Fittings:
1. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
 2. Snubbers: ASME B40.5, NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Terice H.O. Co. or comparable product by one of the following:
1. Flow Design, Inc.
 2. MG Piping Products Co.
 3. National Meter, Inc.
 4. Peterson Equipment Co., Inc.
 5. Sisco Manufacturing Co.
 6. Terice, H. O. Co.
 7. Watts Industries, Inc.; Water Products Div.
- C. 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.
- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- E. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for water service at 20 to 200 deg F (minus 7 to plus 93 deg C) shall be CR.
 2. Insert material for water service at minus 30 to plus 275 deg F (minus 35 to plus 136 deg C) shall be EPDM.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install thermometers on the inlet and outlet of each domestic, hot-water storage tank.
- B. Provide the following temperature ranges for thermometers:
 - 1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions (Minus 1 to plus 82 deg C, with 1-degree scale divisions) .
 - 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions) .

3.2 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages for discharge upstream and downstream of each pressure-reducing valve.
- B. Pressure scale: 0 to 100 psi at 2 psi scale divisions.

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.
- C. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- E. Install remote-mounting pressure gages on panel.
- F. Install needle-valve and snubber fitting in piping for each pressure gage.
- G. Install test plugs in tees in piping.
- H. Install permanent indicators on walls or brackets in accessible and readable positions.
- I. Install connection fittings for attachment to portable indicators in accessible locations.
- J. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.
- K. Adjust faces of thermometers and gages to proper angle for best visibility from the floor.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Brass swing check valves.
- B. Related Sections:
 - 1. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.3 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.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 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.

1.6 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 ball and plug valves open to minimize exposure of functional surfaces.
- 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.

PART 2 - PRODUCTS

2.1 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. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. 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.
- E. Valve-End Connections:
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - 2. Threaded: With threads according to ASME B1.20.1.
- F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

- A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products from Apollo or one of the following:
 - a. Watts Industries.
 - b. Nibco.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: "Lead Free" Forged brass.

- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
 - a. Conbraco Industries/Apollo Valves
 - b. Watts Industries.
 - c. Nibco.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: "Lead Free" ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 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.

3.4 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.
- 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 (DN 50) and Smaller: Threaded ends except where PropPress option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 3 and Smaller:
 - 1. Ball Valves: May be provided with ProPress ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, brass with bronze trim.
 - 3. Bronze Swing Check Valves: Class 150, bronze disc.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Copper pipe supports.
- B. Trapeze pipe hangers.
- C. Pipe positioning and acoustical isolation systems.
- D. Equipment supports.

1.3 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."

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Copper pipe supports.
 - 3. Pipe positioning and acoustical isolation systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Carpenter & Paterson, Inc.
 - 3. ERICO/Michigan Hanger Co.
 - 4. Grinnell Corp.
- C. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. Power-Strut Div.; Tyco International, Ltd.
 - 4. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

2.5 PIPE POSITIONING AND ACOUSTICAL ISOLATION 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.
- B. Available Manufacturers:
 - 1. HOLDRITE Corp.; Hubbard Enterprises.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 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 or copper on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. 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 (DN 15 to DN 750).
 - 2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
- F. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
- 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 (DN 20 to DN 500).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.
- H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 3. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 4. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- J. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- K. Use pipe positioning and acoustical isolation systems in walls and pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 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.

1. Unless specifically noted otherwise piping shall be attached to the top of steel bar joist at panel points, top or bottom of steel beam flanges and sides of wooden beams. Piping shall not be attached to steel decking under any circumstances.
- 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. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Pipe Positioning and Acoustical Isolation System Installation: Install support devices to make rigid and quiet supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. 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.
- H. Insulated Piping: Comply with the following:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 3. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 4. Insert Material: Length at least as long as protective shield.
 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

3.4 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 1-1/2 inches.

END OF SECTION 220529

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 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

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) 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 (64 by 19 mm).
 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), 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 self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm).

2.3 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. Manufacturer's Labels for Heat Traced Piping may be adhesive type.
- 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 (38 mm) high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
1. Tag Material: Brass, 0.032-inch (0.8-mm 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 (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

3.1 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.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 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 (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
 7. "Heat Traced" Labels shall be located every ten feet along each run.
- B. Pipe Label Color Schedule:
 1. Domestic Cold Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 2. Domestic Hot Water and Hot Water Return Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; 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 (38 mm), round.
 - b. Hot Water: 1-1/2 inches (38 mm), round.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Fiberglass.
 - 2. Tapes.
 - 3. Securements.
 - 4. Corner angles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 4. Detail field application for each equipment type.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

- 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.

1.5 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.

1.6 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.

1.7 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

2.1 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: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Fiberglass, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F (454 deg C) Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 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. Fiberglass Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. 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.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 SEALANTS

- A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.

2.4 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches (75 mm).
 3. Thickness: 11.5 mils (0.29 mm).
 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches (50 mm).
 3. Thickness: 6 mils (0.15 mm).
 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.5 CORNER ANGLES

- A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 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.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 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. Keep insulation materials dry during application and finishing.
- F. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- G. Install insulation with least number of joints practical.
- H. 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.
- I. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- J. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- K. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- L. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- M. 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.

3.4 PENETRATIONS

- A. 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 (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. 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 and fire-resistive joint sealers.
- D. 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 "Penetration Firestopping".

3.5 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 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. 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. 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. 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. 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.
 - 6. 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.

3.6 FIBERGLASS 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 (150 mm) 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 Fittings and Elbows:

1. Not used.
2. Install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Place PVC cover fitting over the elbow and secure with bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Not used.
2. Install sections of pipe insulation, to a thickness equal to adjoining pipe insulation.
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.

3.7 FINISHES

- A. All insulated piping located in the mechanical rooms shall be covered and sealed with white PVC jacketing.
- B. All exposed insulated piping within kitchens, custodial closets, coolers and freezers shall be covered and sealed with white PVC jacketing.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS ½ and NPS ¾ : Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - 2. NPS 1 (DN 25) and NPS 1-1/4 (DN 32): Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - 3. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- B. Domestic Hot Water:
 - 1. NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
 - 2. NPS 1-1/4 (DN 32) : Insulation shall be the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1-1/2 inch (38 mm) thick.
 - 3. NPS 1-1/2 (DN 40) and NPS 2 (DN 50) : Insulation shall be the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1-1/2 inch (38 mm) thick.

END OF SECTION 220700

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SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Escutcheons.
 - 3. Sleeves and sleeve seals.

1.3 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.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
 - 1. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and threaded ends.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
- B. Copper Pressure-Seal-Joint Fittings:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide the following product:
 - a. Viega ProPress.
 - 2. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

3. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- C. Grooved Mechanical Joint Copper Couplings and Fittings:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the following product:
 - a. Victaulic CTS Copper Grooved Piping System.
 2. Couplings for 2 – 8” Victaulic Style 607 Installation Ready Coupling with Grade “P” (Red and Blue Color Stripe Color Code), UL Classified in accordance with ANSI/NSF 61 for cold domestic water and hot +140 degrees (+180 maximum) potable water service, and ANSI/NSF 372.

2.3 PIPING JOINING MATERIALS

- A. Viega “ProPress” Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- B. Victaulic Grooved Copper System with tubing grooved with tools as supplied by the manufacturer.

2.4 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.

PART 3 - EXECUTION

3.1 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, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.
- C. Install domestic water piping level and plumb.
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.

- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- G. Install piping adjacent to equipment and specialties to allow service and maintenance.
- H. Install piping to permit valve servicing.
- I. 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.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.

3.2 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. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

3.3 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 (DN 50) and smaller.
- 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.

3.4 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.
- 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 (10 mm).
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

F. Install supports for vertical steel piping every 15 feet (4.5 m).

3.5 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 water piping provided by division 33.

1. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - a. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - b. 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.
 - c. 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 (DN 65) and larger.

3.6 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

C. Escutcheons for Existing Piping:

1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.

3.7 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.

3.8 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:
 - 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 50 psig (345 kPa) above 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. Prepare test and inspection reports.

3.9 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. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 5. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 - 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 described in either AWWA C651 or AWWA C652 or follow procedures 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 (50 mg/L) 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 (200 mg/L) 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.

3.11 PIPING SCHEDULE

- A. Aboveground domestic water piping, NPS 3 and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper pressure-seal joints.

3.12 VALVE SCHEDULE

- 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 3" and smaller.
 - 2. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Strainers.
 - 3. Outlet boxes.
 - 4. Drain valves.
 - 5. Dishwasher air-gap fittings.
 - 6. Water hammer arresters.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 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:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 01 through 09."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 2. Standard: ASSE 1001.
 3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
 4. Body: Bronze.
 5. Inlet and Outlet Connections: Threaded.
 6. Finish: Rough bronze.

2.2 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
 1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
 2. Body: Lead-Free Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 for NPS 2-1/2 (DN 65) and larger.
 3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
 5. Perforation Size:
 - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm) .
 - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm) .
 6. Drain: Factory-installed, hose-end drain valve.

2.3 OUTLET BOXES

- A. Ice Maker OB-1:
 1. Manufacturers: Subject to compliance with requirements, provide products by Oatey or one of the following:
 - a. Acorn Engineering Company.
 - b. Sioux Chief.
 2. Mounting: Recessed.
 3. Material and Finish: Plastic box and semi-cover faceplate.
 4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
 5. Supply Shutoff Fitting: Supply Shutoff Fitting: NPS 1/2 (DN 15) independent ball valve with integral hammer arrestor on valve and NPS 1/2 (DN 15) copper, water tubing.
 6. Drain: N/A

- B. Dishwasher OB-2:
1. Manufacturers: Subject to compliance with requirements, provide products by Oatey or one of the following:
 - a. Acorn Engineering Company.
 - b. Sioux Chief.
 2. Mounting: Recessed.
 3. Material and Finish: Plastic box and semi-cover faceplate.
 4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
 5. Supply Shutoff Fitting: Supply Shutoff Fitting: NPS 1/2 (DN 15) independent ball valve with integral hammer arrestor on valve and NPS 1/2 (DN 15) copper, water tubing.
 6. Drain: N/A

2.4 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
 3. Size: NPS 3/4 (DN 20).
 4. Body: Copper alloy.
 5. Ball: Chrome-plated brass.
 6. Seats and Seals: Replaceable.
 7. Handle: Vinyl-covered steel.
 8. Inlet: Threaded or solder joint.
 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.5 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by Sioux Chief or one of the following:
 - a. Oatey
 - b. PPP Inc
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 3. Standard: ASSE 1010 or PDI-WH 201.
 4. Type: Copper tube with piston.
 5. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.6 PRESSURE REDUCING VALVE

- A. Pressure Reducing Valve:
1. Manufacturers: Subject to compliance with requirements, provide products by Watts or one of the following:
 2. Basis-of-Design Product: Watts, with integral union, strainer and pressure gauge.
 - a. Watts

- b. Wilkins.
- 3. Standard: ASSE 1003,
- 4. Pressure Setting: 70 psi.
- 5. Inlet/Outlet Size: NPS 1/2".

PART 3 - EXECUTION

3.1 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. Backflow preventers shall be accessible from a standing position on the floor.
 - 3. 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.
 - 4. Do not install bypass piping around backflow preventers.
- C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install thermometers and water regulators if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- G. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- H. Install water hammer arresters in water piping according to PDI-WH 201.
- I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow
- J. Install drainage-type, trap-seal primer valves as lavatory trap or flushometer with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

- K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 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."
- C. Connect wiring according to Division 26.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Primary, thermostatic, water mixing valves.
 - 2. Primary water tempering valves.
 - 3. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle 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.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

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SECTION 221316 - SANITARY WASTE, VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following for soil, waste, sanitary vent piping inside the building including vents through the roof:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
- B. Soil, Waste, and Vent Piping: 10-foot head of water 30 kPa or 5 psi.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 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.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 PEX TUBE AND FITTINGS FOR TRAP PRIMER DRAINS

- A. PEX Distribution System: ASTM F 877, SDR 9 tubing.
 - 1. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Exposed drainage kitchen from sinks and equipment shall be the following:
 - 1. Type "L" copper with soldered joints and fittings.
- B. Aboveground, soil and waste piping shall be the following:
 - 1. Solid-wall PVC DWV pipe, PVC socket fittings, and solvent-cemented joints.
- C. Aboveground, grease, grease vent piping shall be the following:
 - 1. Solid-wall PVC DWV pipe, PVC socket fittings, and solvent-cemented joints.

- D. Underground, soil, waste, and vent piping shall be the following:
 - 1. Solid-wall PVC DWV pipe, PVC socket fittings, and solvent-cemented joints.
- E. Underground, grease, grease vent piping shall be the following:
 - 1. Solid-wall PVC DWV pipe, PVC socket fittings, and solvent-cemented joints.
- F. Condensate Waste Piping: PVC Schedule 40 pipe, PVC socket fittings, and solvent-cemented joints.
- G. Condensate Waste Piping within kitchen freezers/coolers: PVC Schedule 40 pipe, PVC socket fittings, and solvent-cemented joints with single heat trace circuit.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- D. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- H. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- I. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.

3.5 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 according to the following:
- 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.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- E. Maximum spans below were taken from MSS SP-69 for water service and from model plumbing codes. Most restrictive piping and spacing dimensions are shown.
- F. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and 5 (DN 100 and 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
 - 4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
- H. Install supports for vertical PVC & Copper piping every 48 inches (1200 mm).
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. 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.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. 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 separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 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 required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.

- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Solids Interceptor
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Fixtures".

PART 2 - PRODUCTS

2.1 SOLIDS INTERCEPTOR

- A. Solids Interceptor SI-1:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Practicon Gleco.
 - 2. Description: Practicon Gleco plaster sink trap Model 7078713, 64 oz bottles model 70-78712.

2.2 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 - 1. Description: Shop or field fabricate, PVC Schedule 40, soil-pipe fittings. Include P-trap, and riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 - 2. Size: Same as connected waste piping.
- 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.

PART 3 - EXECUTION

3.1 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 (DN 100). Use NPS 4 (DN 100) 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 100 feet for all piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3.3 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 221319

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories and sinks.
 - 2. Dishwasher air-gap fittings.
 - 3. Stainless steel sinks.
- B. Related Sections include the following:
 - 1. Division 10.
 - 2. Division 22 Section "Domestic Water Piping Specialties" and "Sanitary Waste Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. 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, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- C. FRP: Fiberglass-reinforced plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

- D. Warranty: Special warranty specified in this Section.

1.5 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Plastic Mop-Service Basins: ANSI Z124.6.
 - 2. Stainless-Steel Sinks: ASME A112.19.3.
 - 3. Vitreous-China Fixtures: ASME A112.19.2M.
- G. Comply with the following applicable standards and other requirements specified for sink faucets:
 - 1. Faucets: ASME A112.18.1.
 - 2. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 3. NSF Potable-Water Materials: NSF 61.
 - 4. Pipe Threads: ASME B1.20.1.
 - 5. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - 6. Supply Fittings: ASME A112.18.1.
 - 7. Brass Waste Fittings: ASME A112.18.2.
- H. Comply with the following applicable standards and other requirements specified for shower faucets:
 - 1. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 - 2. Faucets: ASME A112.18.1.
 - 3. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 - 4. Hose-Coupling Threads: ASME B1.20.7.
 - 5. Manual-Control Antiscald Faucets: ASTM F 444.
 - 6. Pipe Threads: ASME B1.20.1.
 - 7. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

8. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

I. 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. Brass Waste Fittings: ASME A112.18.2.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Dishwasher Air-Gap Fittings: ASSE 1021.
2. Flexible Water Connectors: ASME A112.18.6.
3. Floor Drains: ASME A112.6.3.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Off-Floor Fixture Supports: ASME A112.6.1M.
6. Pipe Threads: ASME B1.20.1.
7. Plastic Toilet Seats: ANSI Z124.5.
8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period for Commercial Applications: Three year(s) from date of Substantial Completion.

1.7 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 Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
2. Flushometer Valve, Repair Kits: 4 of each type.
3. Toilet Seats: 4 of each type installed.

PART 2 - PRODUCTS

2.1 SINK FAUCETS

A. Sink Faucets SK-1 & SK-2

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucet or comparable manufacturer from the following:

- a. Chicago Faucets.
- b. Water Saver
- c. Zurn
- 2. Description: Gooseneck spout with two handles, 1.0 gpm aerated flow outlet, ceramic disc cartridge; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: General-duty, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 1.0 gpm, unless otherwise indicated.
 - d. Centers: 8 inches.
 - e. Mounting: Deck.
 - f. Handle(s): 4" Wrist blade handle.
 - g. Inlet(s): NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter.
 - h. Spout Type: 8" rigid gooseneck.
 - i. Spout Outlet: Aerator.
 - j. Vacuum Breaker: Not required.
 - k. Operation: Ceramic Disc, manual.

B. Sink Faucets: SK-3:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucet or comparable manufacturer from the following:
 - a. Chicago Faucets.
 - b. Zurn
 - c. Water Saver
- 2. Description: Gooseneck spout with wrist blade handle, 2.2 gpm aerator, pressure compensating aerator; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: General-duty, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 2.2 gpm, unless otherwise indicated.
 - d. Centers: 8"
 - e. Mounting: Wall
 - f. Handle(s): 4" wrist blade
 - g. Inlet(s): NPS 1/2 (DN 15) female connection.
 - h. Spout Type: 12" L-type swing spout
 - i. Spout Outlet: Aerator.
 - j. Vacuum Breaker: Not required.
 - k. Operation: Ceramic Disc, manual

2.2 COMMERCIAL SINKS

A. Commercial Sinks, SK-1:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Just or a comparable product by one of the following:
 - a. Elkay.
- 2. Description: One-compartment, undermount, stainless-steel commercial sink with rear center drain location, ADA compliant sink bowl, fully coated bottom.
 - a. Overall Dimensions: 23-1/2" left to right by 18-1/4" front to back by 5-3/8" deep.
 - b. Metal Thickness: 18 gauge.
 - c. Faucet Holes: Three

- d. Compartment:
 - 1) Bowl Dimensions: 21" left to right by 15-3/4" front to back by 5-3/8" deep.
 - 2) Drain: Grid Strainer.
 - a) Location: Rear Center of compartment.
- e. Supplies: NPS 1/2 (DN15) chrome-plated copper with chrome plated, quarter turn ball valve stops.
- f. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; tubular brass waste to wall; and wall escutcheon(s).
- g. Provide offset tailpiece.

B. Commercial Sinks, SK-2:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Just or a comparable product by one of the following:
 - a. Elkay.
- 2. Description: One-compartment, undermount, stainless-steel commercial sink with rear center drain location, ADA compliant sink bowl, fully coated bottom.
 - a. Overall Dimensions: 23-1/2" left to right by 18-1/4" front to back by 7-1/2" deep.
 - b. Metal Thickness: 18 gauge.
 - c. Faucet Holes: Three
 - d. Compartment:
 - 1) Bowl Dimensions: 21" left to right by 15-3/4" front to back by 7-1/2" deep.
 - 2) Drain: Grid Strainer.
 - a) Location: Rear Center of compartment.
 - e. Supplies: NPS 1/2 (DN15) chrome-plated copper with chrome plated, quarter turn ball valve stops.
 - f. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; tubular brass waste to wall; and wall escutcheon(s).
 - g. Provide offset tailpiece.

C. Commercial Sinks, SK-3:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Aero or a comparable product by one of the following:
 - a. Advance Tabco
 - b. Elkay
 - c. Just Manufacturing
- 2. Description: One-compartment, left drain board, sink on four adjustable legs.
 - a. Overall Dimensions: 46" left to right by 30" front to back by 14" deep.
 - b. Metal Thickness: 16 gauge.
 - c. Faucet Holes: Two on backsplash with 8" centers.
 - d. Drain Board: 18" drain board located on left side of sink
 - e. Compartment:
 - 1) Bowl Dimensions: 24" left to right by 24" front to back by 14" deep.
 - 2) Drain: Lever Waste assembly.
 - a) Location: Center of compartment.
 - f. Supplies: NPS 1/2 (DN15) chrome-plated copper with chrome plated, quarter turn ball valve stops.
 - f. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; tubular brass waste to wall; and wall escutcheon(s).
 - g. Interceptor: Provide SI-1

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- C. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- D. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- E. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust high temperature limit stops on faucets. Replace damaged and malfunctioning units.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities.

END OF SECTION 224000

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SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide labor, materials, accessories, and other related items as required to complete operations in connection with the complete installation of the HVAC and mechanical systems as indicated on the Drawings and as specified herein.

1.2 RELATED REQUIREMENTS

- A. Conditions of the Contract apply to the work, including the work of this Division. Examine Contract Documents for requirements affecting the work.
- B. Provide cooperation with, and assistance to, the Commissioning Agent as specified under “Responsibilities” in Division 01 Section “General Commissioning Requirements.”
- C. Provide cooperation with, and assistance to, the Testing and Balancing (TAB) Agent specified in Division 23 Section “Testing, Adjusting, and Balancing for Mechanical Systems.”

1.3 MECHANICAL PRE-CONSTRUCTION MEETING

- A. Conduct a mechanical conference at Project site to comply with requirements of Division 01 Section “Project Management and Coordination” and the following:
 - 1. At least 14 days prior to beginning of mechanical work, conduct a meeting to review detailed requirements for mechanical systems installation and testing requirements. Review mechanical Drawings and Specifications, discuss project specific details and requirements, and review and discuss expectations for quality control. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with mechanical systems installation to attend conference, including, but not limited to, the following:
 - a. General Contractor's superintendent.
 - b. Mechanical Subcontractors’ project managers.
 - c. Mechanical Subcontractors’ job foremen.
 - d. Sheetmetal job foreman.
 - e. Plumbing job foreman.
 - f. Controls job foreman.
 - g. Project mechanical Engineer/designer.
 - h. Job clerk.
 - i. Architect’s construction administrator.

1.4 CONTRACT DOCUMENTS

- A. The general location of the apparatus and the details of the work are indicated on the Drawings. Exact locations not indicated shall be determined at the site as the work progresses and shall be subject to the Architect's approval.
- B. It is not intended that the Drawings shall show every pipe, pipe rise, pipe drop, duct rise, duct

drop, pipe fitting, duct fitting, or appliance, but it shall be a requirement to furnish, without additional expense, material and labor necessary to complete the systems in accordance with the design intent and with the highest possible quality available.

- C. The Contractor shall take no advantage of any apparent error or omission in the Drawings and Specifications, and the Designer shall be permitted to make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the Drawings and Specifications. Where errors or omissions appear in the Contract Documents, the Contractor shall promptly notify the Designer in writing of such errors or omissions. Inconsistencies in the contract documents are to be reported before proposals are received, whenever found.
- D. Should the Drawings or the Specifications disagree in themselves or with each other, the Contractor shall provide the better quality or greater quantity of work and/or materials unless otherwise directed by written addendum to the Contract Documents.

1.5 ALTERATIONS

- A. Execute alterations, additions, removals, relocations, new work, and other related items as indicated or required to provide a complete installation in accordance with the intent of the Contract Documents, including changes required by building alterations.
- B. Existing work disturbed or damaged by the alterations or the new work shall be repaired or replaced to the Architect's satisfaction and at no additional cost to the Owner.
- C. Existing ductwork, piping, and other systems indicated to be removed, shall be removed from the site. Cap off existing services remaining. The Owner retains the right to ownership of heating and ventilating equipment scheduled to be removed; store such equipment where requested by the Owner. Material not retained by the Owner shall be removed from the site.

1.6 CONTINUITY OF SERVICE

- A. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted service for the building or any of its locations. Any unavoidable conditions requiring reduced building capacity shall be arranged for by programming with the Owner's duly authorized representative at the building subject to the Architect's approval. If necessary, temporary work shall be installed to provide for the condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal service shall be performed during an overtime period to be scheduled with the Owner. Costs for overtime work shall be included in the Bid.

1.7 REQUIREMENTS

- A. Installation Instructions: Obtain manufacturer's printed installation instructions to aid in properly executing work on major pieces of equipment. Install equipment in accordance with manufacturer's recommendations.
- B. Objectionable Noise, Fumes and Vibration:
 - 1. Mechanical and electrical equipment shall operate without creating objectionable noise, fumes, or vibration, as determined by the Architect.
 - 2. If such objectionable noise, fumes, or vibration is produced and transmitted to occupied

portions of building by apparatus, piping, ducts, or any other part of mechanical and electrical work, make necessary changes and additions, as approved, without extra cost to Owner.

C. Equipment Design and Installation:

1. Uniformity: Unless otherwise specified, equipment or material of same type or classification, used for same purposes, shall be product of same manufacturer.
2. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog number shall be designed in conformity with ASME, IEEE, or other applicable technical standards, suitable for maximum working pressure, and with neat and finished appearance.
3. Installation: Erect equipment aligned, level, and adjusted for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements may be made, as approved.

D. Hanging of Equipment, Ductwork and Piping:

1. Attach supports only to structural framing members and non-metal deck concrete slabs.
2. Support equipment, ductwork, and piping from the top chord of bar joists at the "Panel Points" or from the top flange of beams. Provide intermediate support consisting of steel angle or equal as required where supports are installed between joist spaces.
3. Piping 2-inch (50 mm) nominal and smaller may be supported from the bottom chord of the bar joists at the "Panel Points" or from the bottom flange of the beams.
4. Do not anchor supports to metal decking with or without a concreted slab.

E. Protection of Equipment and Materials: Responsibility for care and protection of materials and mechanical work rests with the Contractor until the entire project has been completed, tested and the project is accepted by the Owner.

F. Ceiling Mounting: Where ceiling mounting is indicated or specified, use suspended platform, threaded rod, or strap hangers, bracket or shelf, whichever is most suitable for equipment and its location. Construct of structural steel members, steel plates, or rods, as required; brace and fasten to building structure or to inserts as approved, or as detailed.

G. Foundations: Provide Housekeeping pad in accordance with Section "Hangers and Supports for HVAC Piping and Equipment"

1.8 ACCESS PANELS

A. Access panels required for items furnished under Division 23 shall be provided under this Division.

B. Selection and installation of access panels shall be in accordance with Division 08 Section "Access Doors and Frames."

C. Access panels shall be standard panels, 12 inch x 16 inch (305 mm x 406 mm) minimum unless indicated otherwise. Door shall be flush type of 14 gauge steel hinged to 16 gauge frame with drywall bead. Panels installed in areas of high moisture concentration, such as locker rooms, near plumbing fixtures, food preparation areas, or outdoors, shall be fabricated of paintable stainless steel or aluminum for corrosion resistance.

- D. Access panels in fire-rated construction shall have the same UL rating as the building assembly in which they are installed.
- E. Provide access panels in building construction where required for access to duct access doors or other components such as valves, air vents, actuators, volume dampers, motorized dampers in ductwork, duct smoke detectors, and other related items.

1.9 ELECTRIC WORK

- A. Provide motors, pilot lights, controllers, limit switches, and other related items for equipment provided under Division 23.
- B. Except as noted, required line switches, fused switches, and other related items and necessary wiring to properly connect equipment to motors and switches shall be furnished and installed under Division 26, Electric.
- C. Provide complete wiring system for automatic temperature controls as specified under Section Division 23 Section "Instrumentation and Controls for Mechanical Systems."
- D. Wiring shall conform to the requirements of the National Electrical Code.

1.10 FIRESTOPPING

- A. Firestopping for penetrations of ductwork, piping and equipment through fire rated and smoke rated building assemblies, including but not limited to partitions, walls, floors, ceilings, and roofs, shall be provided by Division 07.
- B. Selection of firestopping materials and installation of firestopping materials shall be in accordance with Division 07. Coordinate with other trades for a consistent installation.
- C. Refer to Architectural Drawings for locations of fire rated building assemblies.

1.11 DUCT MOUNTED SMOKE DETECTORS

- A. Duct mounted smoke dampers shall be furnished under Division 26.
- B. Smoke sampling tubes shall be installed by Division 23. Coordinate location with Division 26.
- C. Whether or not indicated on the Drawings, air handling systems with a design capacity over 2000 CFM shall have duct mounted smoke detection equipment in accordance with the requirements of NFPA 90A and BOCA.

1.12 SUBMITTALS

- A. After award of Contract and before installation, submit for approval Shop Drawings, bulletins, Product Data, Samples, and other related items.
- B. Submit Shop Drawings and Product Data as required in each Section. Submittal shall include physical data and performance data required to verify compliance with the Contract Documents.
- C. Submit Samples as required in each Section, and as indicated on the Drawings. These will

generally be retained by the Architect/Engineer, unless otherwise indicated. Contractor may request these items returned; provide return shipping for returns.

- D. Submit Mock-Ups as required in each Section, and as indicated on the Drawings. For general mock-up procedures, refer to Division 01. Deliver to the Architect/Engineer for review if so indicated. Provide return shipping.
- E. Architect/Engineer's review will not include the review, coordination, or verification of dimensions or quantities; these shall be the responsibility of the Contractor.

1.13 SUBSTITUTIONS

- A. Comply with provisions of the Instructions to Bidders and General Requirements of the Specifications.
- B. Comply with provisions of the Division 00 "Instructions to Bidders and the USNH General Conditions."
 - 1. If a manufacturer's name, trade name or proprietary designation is used in the Contract Documents, the time for submission for review of proposed substitutions shall be within 10 working days after the Award of Contract. After that time, no substitutions will be reviewed.
- C. The first item listed under "Acceptable Manufacturers", "Approved Manufacturers" or "Manufacturers" is the design basis.
 - 1. Other manufacturers listed may be used in the base Bid, but conformance with details of the Specifications, as well as dimensional and electrical data, shall be verified by the Contractor.
 - 2. Architect/Engineer has not verified that each listed manufacturer has the ability to provide an acceptable substitution for the basis-of-design product. Contractor may not assume that substitutions will be approved.
 - 3. Modifications required as a result of differences between the design basis item and the submitted and approved item must be approved by the Architect and made at the Contractor's expense. As an example, if a rooftop HVAC unit is submitted and approved and if the unit's dimensions and weight are different from those of the unit which was used as the design basis, the Contractor shall be responsible for building structural modifications required to accommodate the submitted and approved unit, at no additional cost to the Owner.
 - 4. When, in the Architect or Engineer's opinion, architectural or engineering services are necessary for the coordination of substituted items, the Contractor shall reimburse the Owner for the cost of these services.
 - 5. For items which have no manufacturers listed, any item conforming with the Contract Documents is acceptable.
- D. Substitutions from manufacturers or providers which are not listed may be proposed within the time allowed in the General Requirements of the Specifications.
 - 1. The exception to this is products for which the list of manufacturers or providers is limited by the wording "no substitutions" or similar wording.

1.14 COORDINATION

- A. Coordinate scheduling, submittals, and Work of the various Sections of Specifications to

assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

- B. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Divisions having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. In finished areas, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- E. Coordinate completion and clean-up of work of separate Sections in preparation for Substantial Completion.
- F. 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.

1.15 REQUESTS FOR ARCHITECT'S CADD DRAWINGS

- A. In lieu of generating their own CADD drawings, the Contractor may elect to use the Architect's electronic copies of CADD drawings for the purpose of developing coordination drawings, developing control system graphics or for other reasons that pertain to the requirements of this Contract. If the Contractor elects to utilize the Architect's electronic copies of CADD drawings, the electronic files shall be purchased from the Architect at the Architect's current billing rate per drawing. The Contractor shall provide payment and shall sign a release-of-liability form before electronic CADD drawings are released.

1.16 CLEANING

- A. Remove debris from site daily.
- B. Material and pieces of equipment shall be turned over to the Owner free of dust and dirt, both inside and out.
- C. At the completion of the Project, equipment shall have a clean, neat appearance of factory finish by cleaning or repainting as required.
- D. At the completion of the Project, surfaces exposed to view shall have a clean, neat appearance of finish free from smudges and scratches by cleaning or repainting as required.

1.17 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect/Engineer 7 days 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, or other conditions which may cause damage.
- D. Verify that 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 responsible manufacturer's representative in accordance with manufacturer's 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.

1.18 FACTORY START-UP AND START-UP REPORTS

- A. Provide factory start-up of mechanical equipment listed below. Factory start-up shall be performed by a factory authorized representative of the equipment manufacturer. When factory start-up is successfully completed for each piece of mechanical equipment listed below, submit a formal start-up report to the Architect for approval. Start-up report shall be formatted in accordance with equipment manufacturer's recommendations. Start-up report shall be typed, not hand written, and shall be submitted in a clean and legible form.
- B. Equipment requiring factory start-up
 1. Air handling units
 2. Kitchen Hood Fire Suppression Systems.
 3. Kitchen ventilation systems

1.19 ADJUSTMENTS AND OWNER'S INSTRUCTIONS

- A. After completion of the installation work called for in the Contract Documents, furnish necessary mechanics or engineers for the adjustment and operation of the systems, to the end that the systems are perfectly adjusted and turned over to the Owner in perfect working order. Further instruct the Owner's authorized representative in the care and operation of the installation, providing framed instruction charts, directions, and other related items.
- B. Instructors providing Owner training shall be experienced and familiar with the jobsite.

1.20 TESTING

- A. After the entire installation is completed and ready for operation, test the systems as outlined in Division 23 Section "Testing, Adjusting and Balancing for HVAC." These tests are supplementary to detailed tests specified herein or directed. The Owner will provide water and electric current for the test. Provide necessary labor, test pump, gauges, meters, other instruments, and materials. Perform tests in the presence of the Architect or their representative.

- B. Perform other tests specified in individual Sections of this Specification.

1.21 COMPLETION OF SYSTEMS

- A. The following mechanical systems shall not be complete until the following conditions are satisfied:
 - 1. Ductwork Systems:
 - a. Ductwork and related components and accessories shall be completely installed and insulated as specified.
 - b. Ductwork leakage testing shall be completed and leakage testing reports shall be submitted and approved.
 - c. Ductwork shall be balanced and a balancing report shall be submitted and approved.
 - d. Commissioning shall be completed.
 - 2. Piping Systems:
 - a. Piping, valves and accessories shall be completely installed, insulated and labeled as specified.
 - b. Piping pressure testing be completed and pressure testing reports shall be submitted and approved.
 - c. Piping systems shall be balanced and a balancing report shall be submitted and approved.
 - d. Commissioning shall be completed.
 - 3. Equipment:
 - a. Equipment, including but not limited to boilers, heat exchangers, terminal heat transfer units, pumps, air handling units, condensing units, chillers, split system air conditioning equipment, and exhaust fans, shall be completely installed.
 - b. Equipment start-up reports shall be completed, submitted and approved.
 - c. Equipment balancing shall be completed and the balancing report shall be submitted and approved.
 - d. Commissioning shall be completed.
 - 4. Automatic Temperature Controls (ATC):
 - a. ATC system shall be completely installed.
 - b. Commissioning shall be completed.
 - c. ATC system shall operate in an automatic mode for a minimum of 4 months during Owner occupancy without substantial deficiencies.

1.22 OPERATING AND MAINTENANCE MANUALS

- A. Furnish quantity required in Division 01 of the Specifications, of bound operating and maintenance manuals. Deliver to the Architect for review. Required quantity is for the Owner; the Architect will not retain a bound copy.
- B. For maintenance purposes, provide approved Submittals, parts lists, specifications, and manufacturer's maintenance bulletins for each piece of equipment. For materials used which have been submitted to the Architect for approval but do not require regular maintenance, such as piping, ductwork, and insulation, provide one copy of approved Submittals.
- C. Provide name, address and telephone number of the manufacturer's representative and service company, for each piece of equipment or material so that service or spare parts can be readily obtained.

1.23 WARRANTY

- A. Provide guarantees and warranties for work under this Contract as indicated in the General Requirements of the Specifications.
- B. Provide manufacturers' standard warranties and guarantees for work by the mechanical trades. However, such warranties and guarantees shall be in addition to and not in lieu of other liabilities which the manufacturer and the Mechanical Contractor may have by law or by other provisions of the Contract Documents.
- C. Guarantee that elements of the systems provided under this Contract are of sufficient capacity to meet the specified performance requirements as set forth in these Specifications or as indicated on the Drawings.
- D. Upon receipt of notice from the Owner of failure of any part of the mechanical systems or equipment during the warranty period, the Mechanical Subcontractor shall replace the affected part or parts.
- E. Furnish a written guarantee covering the above requirements before submitting the application for final payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230500

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SECTION 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Common requirements for electric motors furnished on equipment specified in other Sections, including single phase and three phase electric motors.
- B. Shaft Grounding Rings.
- C. Starters.
- D. Thermal Overload Protection.
- E. Variable Speed Drives.

1.2 REFERENCES

- A. Division 01 Section “References”: Requirements for references and standards.
- B. AFBMA.
- C. NEMA MG 1 - Motors and Generators.
- D. NFPA 70 - National Electrical Code.
- E. UL.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.
- B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.4 REGULATORY REQUIREMENTS

- A. Conform to UL Component Recognition for appropriate sizes.
- B. Conform to NFPA 70 and local energy code.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01: Transport, handle, store, and protect products.
- B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Acceptable Manufacturers:
1. A.O. Smith.
 2. Baldor.
 3. Emerson Motor Technologies.
 4. General Electric.
 5. Greenheck Fan Corporation
 6. Marathon Electric.
 7. Siemens.
 8. Teco-Westinghouse.
 9. Toshiba.
 10. U.S. Motors (division of Emerson Motor Technologies).
 11. WEG.
- B. General Construction and Requirements:
1. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these Specifications.
 2. Motors shall have integral thermal overload protection.
 3. Single Phase Motors for general applications: PSC (permanent split capacitor) where available.
 4. Single Phase Motors for fans:
 - a. EC (electronically commutated) where available.
 - b. PSC (permanent split capacitor) where available, if EC is not available.
 5. Open drip-proof type except where specifically noted otherwise.
 6. Design for continuous operation in 40 degrees C environment.
 7. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 8. Explosion-Proof Motors: UL approved for hazard classification.
 9. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency.
- C. Inverter Duty: Motors for use with variable frequency drives shall be rated for "inverter duty", with winding insulation rated for 1600 Volts and Class H (180 degrees C) temperature rating.
- D. Single-Phase Power for Fans - Electronically-Commutated (EC) Motors - Also Known As Brush-Free DC (BFDC) Motors:
1. Drive: Direct-drive only, not for use with belt drive.
 2. Power Supply: Internal motor circuitry shall convert AC power supplied to DC power to operate the motor.
 3. Turndown: Speed-controllable down to 20 percent of full speed (80 percent turndown).
 4. Speed Control: Integral potentiometer with screwdriver setting, remote potentiometer dial with 24 VDC transformer to generate a 0-10 VDC signal, or integral circuitry to accept a 0-10 VDC signal from the building control system, as indicated and specified.
 5. Efficiency: Minimum of 85 percent efficient at all speeds.
 6. Soft-start type, capable of reliable start at any speed setting.
 7. Enclosure: Open drip-proof.

8. Bearings: Permanently lubricated heavy duty ball bearings.
 9. Overload Protection:
 - a. Automatic Speed Control: In the event of overheating or overloading, the motor electronics slow the motor to operate within its acceptable range.
 - b. Thermal Overload: Internally fused, one-shot type as a last resort to prevent fires.
 - c. Locked Rotor: If the motor sees a locked rotor condition, it will automatically shut itself down, then try to restart 3 times. After the 3rd try, the motor will not attempt to restart until the power is cycled.
- E. Single Phase Power - Permanent-split Capacitor Motors:
1. Starting Torque: Exceeding one fourth of full load torque.
 2. Starting Current: Up to six times full load current.
 3. Multiple Speed: Through tapped windings.
 4. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.
- F. Single Phase Power - Capacitor Start Motors:
1. Starting Torque: Three times full load torque.
 2. Starting Current: Less than five times full load current.
 3. Pull-up Torque: Up to 350 percent of full load torque.
 4. Breakdown Torque: Approximately 250 percent of full load torque.
 5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
 6. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated bearings.
 7. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- G. Single Phase Power - Split Phase Motors:
1. Starting Torque: Less than 150 percent of full load torque.
 2. Starting Current: Up to seven times full load current.
 3. Breakdown Torque: Approximately 200 percent of full load torque.
 4. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
 5. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- H. Three Phase Power - Squirrel-cage Motors:
1. Starting Torque: Between 1 and 1-1/2 times full load torque.
 2. Starting Current: Six times full load current.
 3. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
 4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B energy-efficient motors.
 5. Insulation System: NEMA Class B or better.
 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 7. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000

- hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
8. Sound Power Levels: To NEMA MG 1.
 9. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
 10. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
 11. Nominal Efficiency: To NEMA MG 1, energy efficient for motor sizes 10 and larger.

2.2 SHAFT GROUNDING RINGS

- A. Manufacturers:
 1. Electro Static Technology Inc. - Aegis SGR product line.
 2. Inpro/Seal, a division of Waukesha Bearings Corporation - CDR product line.
- B. Provide shaft grounding rings (SGRs) on 3-phase motors which are intended to be used with variable-frequency drives (VFDs). The SGRs may be furnished by the motor manufacturer as an integral part of the motor, furnished factory-installed by the equipment manufacturer, or furnished for field installation by the equipment installer.
- C. Description: Circumferential micro-fiber ring with metal frame, designed to conduct VFD-induced bearing currents from the motor shaft to ground. Provides protection recommended in NEMA MG 1. Provide with mounting kit including bolts and bracket, or conductive epoxy to adhere to motor casing, to ensure ground connection from the SGR to the motor frame.
- D. Provide SGRs on at least one end of the motor. On motors above 100 hp (74.5 kW), provide a bearing insulation kit on the end of the motor without an SGR.

2.3 STARTERS AND OVERLOADS

- A. Acceptable Manufacturers:
 1. Cerus Industrial, Inc.
 2. Allen-Bradley (division of Rockwell Automation).
 3. Cutler Hammer (division of Eaton Corporation).
 4. General Electric.
 5. Siemens.
 6. Square D (division of Schneider Electric).
- B. Provide motor starters for motors provided under this Division of these Specifications.
- C. Cerus Industrial "BAS" building automation HVAC starters are the basis of design. Features of starters/contactors, disconnects, and temperature controls shall be combined in a single package using these starters. Coordination with Automatic Temperature Controls supplier and installer is required to reduce total project costs.
 1. 3-phase starter features include:
 - a. Multi-tap control power transformer (CPT) for universal control voltage.
 - b. Motor circuit protector disconnect (MCP) with high interrupt rating and lockable operator handle.

- c. Contactors rated as high as 2.5 million electrical operations and 25 million mechanical operations.
 - d. Anti-cycling feature.
 - e. Solid-state electronic overloads with wide adjustment range and highly accurate digital motor protection, including protection for phase loss, phase unbalance, stall and locked rotor conditions. Class 1-30.
 - f. Digital keypad, featuring an H-O-A (Hand, Off, Auto) panel with large, clearly labeled push buttons including a front panel reset function and high-intensity LED indicators for settings.
 - g. Damper and valve actuator control, to open the actuator before starting the fan or pump motor.
 - h. Permissive auto control to disable auto inputs. Commonly used with a high pressure limit switch.
 - i. Universal control inputs, including auto dry input, and wet input for voltages from 20 to 138 VAC or VDC.
 - j. Power failure reset.
 - k. Fireman's override.
 - l. NEMA 1 enclosure with prepunched knockouts. NEMA 3R, 4, 4X, and 12 as required.
 - m. BACnet embedded communications option available.
 - n. UL Listed assembly.
 - o. 5-year warranty.
 - p. Factory printed label or engraved nameplate, designating the equipment served.
2. Single-phase starter (Cerus BAS-1P series) features include:
- a. Manually operated quick-make toggle mechanism lockable in the "Off" position, which shall also function as the motor disconnect.
 - b. Hand/Auto switch, concealed behind sliding cover to discourage tampering.
 - c. Capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output, and fault output.
 - d. Control terminals integrated in the starter.
 - e. Power, run status, and fault LED pilot lights.
 - f. Interposing run relay and current sensing status output relay.
 - g. Voltage and dry inputs for auto run command.
 - h. System override mode (fireman's, occupancy, or manual).
 - i. Solid-state electronic overload with wide adjustment range and highly accurate digital motor protection, including protection for stall and locked rotor conditions. Class 10. Concealed adjustment behind sliding cover.
 - j. Surface mount enclosure, UL Type 1, single gang box installation, with sliding covers for concealed items.
 - k. Power Input: 1-phase, 110-240 VAC, 1-16 Amps, 0.1-1 HP (75 to 745 W).
 - l. Universal Control Inputs: Voltage auto-run 10-130 VAC/DC to energize. Dry auto-run normally-open dry contact closure.
 - m. Control Outputs: Proof of run and fault, normally-open 0.3 Amps at 125 VAC, 1 Amp at 24 VAC.
 - n. Ambient operating temperature -5 to 140 degrees F (-20 to 60 degrees C).
 - o. UL 508A Listed.
 - p. 5-year warranty.

- D. Feature Descriptions:
1. Fireman's Override Input: Causes the starter to run the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or auto. The purpose of the Fireman's Override input is to act as a smoke purge function. Fireman's Override has priority over the Emergency Shutdown input.
 2. Emergency Shutdown Input: Disables the starter from operating in either Hand or Auto mode regardless of other inputs either manual or auto.
 3. Phase Failure Protection: Initiates when phase loss is greater than 70 percent for 3 seconds or phase unbalance is greater than 50 percent for more than 5 seconds.
 4. Cycling Fault Protection: Activates whenever the starter is cycled at a rate of more than 1000 cycles in a one hour period. This feature shall be selectable to be disabled. Cycling fault shall cause overload LED to blink rapidly.
- E. Contactors in starters shall be general purpose NEMA rated for connected H.P. (definite purpose starters not acceptable). Coordinate control voltage with Controls Contractor. Provide auxiliary contacts where required for interlocking of electrical equipment. Provide 2-speed motor starters where indicated or required.
- F. Single phase motors shall have one of the following factory wired methods of motor protection:
1. Integral thermal overload protection in motor and cord with plug and receptacle in unit casing.
 2. Integral thermal overload protection in motor and disconnecting switch mounted in or on casing as specified with equipment.
 3. Switch with thermal overload protection for unprotected motors with switch serving as disconnect device.
- G. For starters associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the starter enclosure to interface with the building's fire alarm system. Upon receipt of a signal from the building's fire alarm system, power to load side of the starter shall be turned off. Circuitry shall be provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, provide a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements of Division 26.

2.4 VARIABLE FREQUENCY DRIVES

- A. Acceptable Manufacturers:
1. ABB (ACH550 Series) (basis of design).
 2. Cerus Industrial, Inc. (P-Series).
 3. Danfoss (VLT FC-100 Series).
 4. Rockwell Automation (Allen-Bradley).
 5. Toshiba (Q7 Series).
 6. Yaskawa (E7 Series).
 7. Schneider Electric (S-Flex)
 8. No substitutions.
- B. The variable frequency drives (VFDs) with options shall be UL listed as a complete assembly and shall be built in compliance with the latest standards of ANSI, IEEE, NEMA and the National Electric Code.

- C. The VFDs shall be designed to meet the requirements of the following standards: IEC801-2, IEC801-4, IEC255-4.
- D. Quality Assurance:
1. Manufacturer: Shall specialize in manufacture, assembly, and field performance of VFDs with minimum 5 years' experience.
 2. The VFD manufacturer shall have an existing representative, exclusively for HVAC applications, an independent service and start-up organization, and a parts stocking depot local to the installation.
- E. Warranty and Start-Up Service:
1. Start-Up Service: The VFD manufacturer shall provide a start-up service package. Service shall include inspection, final adjustment, operational checks, coordination with interface to building's ATC system (coordinate with Division 23 Section "Instrumentation and Controls for HVAC") and a final report for record purpose. Start-up service shall be performed by a factory approved and certified technician.
 2. Report: Submit a report of start-up and initial settings and readings.
 3. Owner Training: Provide a session of at least 4 hours, to train 2 or more of the Owner's representatives in the operation and maintenance of the drives. Schedule the training at the Owner's convenience within normal working hours, within 2 months after Substantial Completion.
 4. Warranty: For a period of 2 years after factory start-up, the VFD manufacturer shall include a full parts and labor on-site warranty at no additional cost.
- F. Construction:
1. Pulse Width Modulated design converting the fixed utility voltage and frequency to a variable voltage and frequency output. The VFD shall employ a full wave bridge rectifier, DC bus choke, DC bus filter capacitors, and Insulated Gate Bipolar Transistors (IGBTs) as the output switching device. SCRs, GTOs and Darlington transistors are not acceptable. The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
 2. 6-pulse (minimum) converter section.
 3. NEMA 1 ABS plastic or metal enclosure.
 - a. Incoming AC power at building power system design's phase and voltage (see Contract Drawings) ± 10 percent, 60 Hz. Output voltage, phase and frequencies compatible with equipment served (see Contract Drawings).
 - b. Humidity 0 to 95 percent (noncondensing and noncorrosive).
 - c. Altitude 0 to 3,300 feet above sea level, without derating.
 - d. Ambient temperature 0 to 40 degrees C.
 - e. Verify actual operating conditions, and derate drive capacity as required.
 4. VFDs shall include the following features:
 - a. Customer interface, including digital display in plain English (code numbers are not acceptable), keypad and customer connections.
 - b. Carrier (Switching) Frequency: Optimized for a 3 kHz or 4 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up technician, in a range at least as low as 1 kHz and as high as 8 kHz. Provide at least the following settings to allow fine tuning: 1 kHz, 4 kHz, and 8 kHz.

- c. Built-in program to automatically vary the carrier (switching) frequency.
Acceptable types of control include:
 - 1) ABB's switching frequency foldback control, reduces heat generated by the IGBTs by reducing the carrier frequency if the heatsink temperature rises above 176-194 degrees F (80-90 degrees C).
 - 2) Danfoss automatic switching frequency modulation, reduces noise at low loads (below 60 percent) by adjusting the carrier frequency up to a selected maximum, and provides maximum power and efficiency at higher loads by adjusting the carrier frequency downward to a more efficient setting.
 - d. The option of either (1) displaying a fault, (2) running at a preset speed, or (3) running at the last known speed (average of last 10 seconds) if the input reference (4-20mA or 2-10V) is lost.
 - e. Automatic restart after an overcurrent, overvoltage, or undervoltage, or loss of input signal protective trip. The number of restart attempts and trial time shall be programmable.
 - f. The ability to start into a rotating load (forward or reverse) and accelerate or decelerate without safety tripping or component damage (flying start).
 - g. Automatic power loss ride through circuit that will utilize the inertia of the load to keep the drive powered. Minimum power loss ride through shall be 1 cycle based on full load and no inertia.
 - h. Isolated power for control circuits.
 - i. Input line fuses.
 - j. Acceptable start/stop commands shall include closure of a contact or switch, application and removal of input power and optional application and removal of 115 VAC on-off signal.
 - k. Load loss detection. Each VFD shall provide a dry contact closure at a field adjustable load threshold to indicate a loss of motor load (for example, broken fan belt or pump cavitation).
 - l. Pilot light cluster to provide visual indication of protective functions and circuit status, including the following LEDs:
 - 1) Power on (Red): Illuminates when main power is applied to the controller.
 - 2) AFC Run (Green): Illuminates to annunciate a drive run condition.
 - 3) AFC Fault (Yellow): Illuminates to annunciate a fault condition.
 - m. Five programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.
 - n. PI setpoint controller integral to the drive, allowing a pressure or flow signal to be connected to the VFD, using the VFD for the closed loop control, eliminating the need for external controllers.
 - o. Three programmable digital relay outputs, rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS.
 - p. Seven programmable preset speeds.
 - q. Six programmable digital inputs for interface with energy management system.
 - r. Two independently adjustable acceleration and deceleration ramps, adjustable from 1 to 1800 seconds.
 - s. Ramp or coast to a stop.
 - t. Two programmable analog outputs to provide 4-20 ma signals linear to output frequency, motor speed, output current, motor torque, motor power, DC bus voltage, and motor voltage.
5. VFD door mounted operator digital display shall include:
- a. Output Frequency

- b. Motor Speed (RPM)
 - c. Motor Current
 - d. Calculated Motor Torque
 - e. Calculated Motor Power
 - f. DC Bus Voltage
 - g. Output Voltage
 - h. Heat Sink Temperature
 - i. Analog Input Values
 - j. Keypad Reference Values
 - k. Elapsed Time Meter
6. VFD speed command input shall include:
- a. Keypad.
 - b. Two analog inputs, each capable of accepting a 0-20 mA, 4-20mA, 0-10V, and 2-10V signal inputs isolated from ground, and programmable via the keypad for different uses. Inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The input shall be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed.
 - c. Floating point input to accept a three wire input from a Dwyer Photohelic gauge or equivalent type instrument.
 - d. RS-485 communications.
7. The VFD shall include the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in plain words.
- a. Overcurrent trip, 200 percent of the VFD's variable torque current rating.
 - b. Overvoltage trip, 130 percent of the VFD's rated voltage.
 - c. Undervoltage trip, 60 percent of the VFD's rated voltage.
 - d. Over temperature, + 70 degrees C.
 - e. Ground fault.
 - f. Adaptable Electronic Motor Overload Protection: Shall protect the motor based on speed, load curve, and external fan parameter. Circuits that protect the motor only at full speed are unacceptable.
 - g. Power line surge protection by means of a metal oxide varistor (m.o.v.).
8. Accessories to be furnished and mounted by the drive manufacturer and contained in a single enclosure (the use of more than one enclosure is not acceptable):
- a. Protection From Harmonics and Voltage Spikes: Provide one of the following:
 - 1) Line Reactors: 3-percent AC input line reactors to reduce harmonic current distortion to the incoming power line, and to provide some protection to the drive from incoming voltage spikes. Provide reactors in each phase of incoming power to each VFD. Install between the input power and the drive's input bridge rectifier (so they protect the rectifier). The line reactor shall provide attenuation of line side voltage transients, thus preventing overvoltage trips or other unnecessary VFD shutdowns and providing a reduction in harmonic current distortion. Line reactors shall be manufactured by TCI of Milwaukee, WI and must meet the following requirements: provide a minimum of 2-1/2 percent line impedance, have a saturation rating of no less than 2.5 times the continuous current rating, and be UL recognized.

- 2) ABB Design: Integral 5 percent swinging chokes in the AC input lines, configured between the input power and the drive's input bridge rectifier (so they protect the rectifier from spikes in input power).
 - a) The swinging choke is an inductor with an inductance value inversely proportional to its operating current. Over a substantial portion of the normal operating current range, the inductance decreases as the current in the choke increases. A conventional or linear choke has a fixed inductance value that changes very little as the operating current varies in the normal operating range.
 - b) The harmonic limiting effectiveness of the swinging choke increases when the operating point is less than maximum power.
 - c) Compared to a standard linear choke, the swinging choke provides superior line harmonic current reduction when the drive's output power is less than or equal to rated output.
 - d) The effective inductance value of a swinging choke at full load is higher than the value of a linear choke of the same physical size.
 - e) The efficiency of a swinging choke is higher than the efficiency of a linear choke of the same inductance value.
 - f) Since the design point BHP is nearly always less than the nameplate horsepower of the selected motor, with swinging chokes the harmonic contribution of the drive will nearly always be less than that at maximum rated output power.
 - g) See U.S. Patent No. 6,774,758, "Low harmonic rectifier circuit" using non-linear inductor(s).
- 3) Danfoss Design: Harmonic suppression and surge suppression integral to the drive using separate components.
 - a) Harmonic Suppression: DC link chokes (inductors) installed between the drive's input bridge rectifier and the inverter bus capacitor, consisting of a dual, 5 percent DC-link reactor on the positive and negative rails of the DC bus. This reactor reduces the level of harmonics reflected back into the building power system without causing a voltage loss at the drive's input, and improves input power factor. The reactor is non-saturating (linear) to provide full harmonic filtering throughout the entire load range. In performance, the harmonic suppression of the DC-link reactor is equivalent to a 5 percent AC line reactor.
 - b) Incoming Power-Line Surge Suppression: Fast-acting Metal Oxide Varistor (or (MOV) installed between the input power and the drive's input bridge rectifier, Zener diodes and oversized DC bus capacitors to provide protection against high potential spikes. When the voltage exceeds 2.3 times the expected incoming voltage for 1.3 milliseconds, the MOV shorts, protecting the internal parts of the drive including the 3-phase full-wave diode bridge. The reactor also acts to reduce input current caused by power line disturbances. Provide 4 MOVs, one on each of the 3 inputs and one attached to the DC Link. Comply with the German specification for surge suppression (VDE 0160).
- 4) Linear chokes or DC link chokes used alone without surge suppression on the incoming power are NOT acceptable as alternatives to line reactors. If they are standard and integral to the VFD, they may be provided in addition to line reactors.

- b. Service switch which provides the ability to service the controller (electrically isolated while in bypass operation) without having to remove power to motor.
 - c. Hand-off automatic switch (HOA), prewired. The HOA switch shall be operable in both the Normal and Bypass (if provided) modes of operation. The switch may be dial type, or momentary-contact pushbutton type with LED indicator lights. The switch may be integral to the standard VFD keypad, if it is a dedicated physical switch that is always available, but it is not allowed to serve any other functions, and it may not be a virtual switch such as on a touchscreen.
 - 1) When Auto mode is selected, the external start command and external reference speed signal shall control the motor.
 - 2) When Hand mode is selected, the motor shall run and the manual potentiometer shall control the motor speed. Other controls and inputs/outputs shall function as in Auto mode.
 - d. Manual potentiometer, dial type with calibrated nameplate. Provide an analog (dial-type) or digital meter to indicate selected speed.
 - 1) If the HOA switch is a dedicated button integral to the VFD keypad, and the potentiometer function is immediately available without any further steps when the HOA is in “Hand” position (such as up-down pushbuttons on the face of the keypad), the potentiometer may be integral to the standard VFD keypad. The speed meter may be a display on the general display screen.
 - e. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. External interlocks and start/stop contacts shall function with drive in hand, auto or bypass.
 - f. Door interlocked disconnect or circuit breaker, padlockable in off position.
 - g. For drives that control fans or pumps which are specified to operate in an automatic lead/lag arrangement, provide automatic alternation device in VFD enclosure. (coordinate with Division 23 Section “Instrumentation and Controls for Mechanical Systems”).
9. Energy Management System Interface
- a. Drive shall have the capability to be controlled and monitored via analog and digital inputs and outputs.
 - b. In addition to analog and digital I/O the VFD shall be capable of communicating with the following controls companies’ communication buses with no extra hardware:
 - 1) Johnson Controls
 - 2) Siemens Controls
 - c. Drive shall have integral capability to be controlled and monitored through BACnet, LonWorks, Modbus, or other serial communication protocol compatible with the building automatic temperature control system. Provide adapter modules as required.
 - d. Coordinate with suppliers and installers of building automatic temperature control system to ensure compatibility and full functionality. See Division 23 Section “Instrumentation and Controls for Mechanical Systems.”
10. In the event of a power failure and upon restoration of power, the variable frequency drive shall remain responsive to its command signal from the building’s energy management/temperature control system. The drive shall not require manual resetting after a power outage in order to respond to the energy management/temperature control system’s command signal.
11. For drives that are associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the VFD enclosure to interface with the building’s fire alarm system. Upon receipt of a signal from the building’s fire alarm

system, power to load side of the VFD shall be turned off. Circuitry shall be provided to ensure that power is off whether the VFD is in the “AUTO”, “HAND” or “BYPASS” mode. If this feature is not available from the VFD manufacturer, provide a contactor on the line side of the VFD to accomplish the same function. The contactor shall meet the requirements of the Electrical Division of the Specifications.

12. Occasional input and output power circuit switching shall be able to be accomplished without interlocks or damage to the drive. If drive design cannot tolerate interruption of output, such as by a disconnect switch mounted between the drive and the motor, provide protective devices and coordinate with installers to protect the drive as specified in Part 3 – Execution in this Section.

G. Compliance with IEEE-519:

1. Input Line Reactors: Provide as specified in “Construction” paragraph of this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Division 01: Manufacturer’s instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Coordinate with Division 26 “Electrical.”
- D. Check line voltage and phase and direction of rotation, and ensure agreement with nameplate.
- E. Install guards in accordance with Codes and OSHA requirements.
- F. Adjust motor overload devices based on motor amperage ratings and field measurements of running amps, to ensure protection of the motor and eliminate nuisance trips.
- G. Disconnect Switch Mounting Height: Install at height above finished floor in accordance with NFPA 70.
 1. In most instances, the center of the grip of the disconnect switch operating handle in its highest position shall be no more than 79 inches (2.0 m) above finished floor or working platform.
 2. Switches and circuit breakers installed adjacent to the equipment served (and within 79 inches (2.0 m) above finished floor or working platform.
- H. Variable Frequency Drives:
 1. Mounting Height:
 - a. Install with the disconnect switch height in accordance with NFPA 70, as described in the paragraph “Disconnect Switch Mounting Height” in this Section.
 - b. The VFD shall be considered to be a piece of equipment served by its disconnect switch, for purposes of NFPA 70, unless otherwise indicated, or otherwise directed by the Authority Having Jurisdiction or by the Owner.
 - 1) If the motor served by the VFD is within sight of the VFD, and within 50 feet (15.2 m) measured in a straight line, this disconnect switch may also serve the motor unless otherwise indicated.

- c. When possible, install VFDs with their operator-interface display at 79 inches (2.0 m) or less above finished floor, unless otherwise indicated or directed.
 - 1) To restrict unauthorized access, VFDs in locations accessible to the public (such as but not limited to classrooms, unrestricted storage rooms, and corridors) shall be mounted with the disconnect switch at 72 to 79 inches (1.8 to 2.0 m) above finished floor, with the VFD operator display and other accessories mounted above the disconnect switch, where ceiling height allows, unless otherwise indicated.
 - 2) In mechanical rooms and other restricted-access locations, mount VFDs at a height for greatest user convenience.
 - d. When possible, mount groups of adjacent VFDs with tops at uniform height above finished floor.
 - e. Because VFDs produce heat, do not install a VFD above another one, or above another heat-producing device. Do not install a VFD below or too near to any heat-sensitive device or room temperature sensor. Provide ventilation space and other means of cooling as required by the manufacturer.
 - f. Install with service and installation clearances as required by the manufacturer.
2. Electrical Connections:
- a. Provide separate metal conduits for drive input power, output power to the motor, and control wiring. Output motor cables from multiple drives shall be run separately.
 - b. Ground each drive separately.
 - c. Ensure that a fused disconnect switch is provided upstream between the transformer and the drive. Fuses are required because they are faster-acting than circuit breakers.
 - d. If drive design cannot tolerate interruption of output, such as by a disconnect switch mounted between the drive and the motor, provide protective devices and coordinate with installers to protect the drive, and coordinate with installers to ensure that no unnecessary switching is installed.
 - 1) When the VFD is out of sight from the equipment served, or is more than 50 feet (15.2 m) from the equipment served, a disconnect switch mounted on or adjacent to the equipment is generally required in Division 26 “Electrical” or by the Authority Having Jurisdiction. If such a disconnect or other switching device is indicated or required, provide protective devices as required by the VFD manufacturer. Such devices typically include an “early-break” auxiliary set of contacts or a “Stop” button on the disconnect switch, field-wired to the VFD’s external fault input or stop input, so that if the switch is opened while the VFD is running, the input will shut off the output of the VFD. The VFD stop method must be set to “Coast.” Provide field wiring in conduit.
 - 2) Provide engraved nameplates at disconnect switches and other devices, instructing users on the proper operation of these devices to prevent damage to the VFD.
3. Carrier Frequency: Adjust to minimize noise, but also to minimize the potential for motor bearing damage due to VFD-induced shaft voltage.
- a. VFDs convert line AC voltage to a pulse width modulated (PWM) AC voltage of variable frequency. The switching frequency of these pulses is referred to as the “carrier frequency.” The switching induces a voltage on the rotor shaft, which, if it builds up to a sufficient level, can discharge as “bearing current” to ground through the bearings. This has an electric discharge machining (EDM) effect, causing

- pitting of the bearing's rolling elements and raceways. This effect can be minimized by proper setup.
- b. The higher the carrier frequency, the higher the rate of the current discharge pulses, and the more likely EDM will occur. At higher carrier frequencies the VFD will generally run quieter; however, it becomes more destructive on the motor insulation and bearings.
 - c. Adjust the carrier frequency as low as possible without creating unacceptable audible noise levels, and to avoid frequencies above 6 kHz altogether if possible.
4. Coordinate with building controls systems as specified in Part 2 of this Section.
 5. Perform startup service, and submit report.
 6. Provide warranty service.
 7. Provide Owner training.

END OF SECTION 230513

SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and equipment hangers and supports.
- B. Sleeves and seals.
- C. Flashing and sealing equipment and pipe stacks.

1.2 RELATED SECTIONS

- A. Division 09 Section “Painting.”
- B. Division 23 Section “HVAC Piping Insulation.”
- C. Division 23 Section “Hydronic Piping.”

1.3 REFERENCES

- A. ASME.
- B. ASTM
- C. MSS.
- D. NFPA 70 - National Electrical Code

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures”.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data: Provide manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable Codes for support of piping.
- B. Supports for Electrical: In conformance with NFPA 70 and Division 26 of the Specifications.

PART 2 - PRODUCTS

2.1 HANGERS, SUPPORTS, & PIPE CLAMPS

- A. Approved Manufacturers (first manufacturer is basis of design):
 - 1. Strut Hangers:
 - a. Unistrut (division of Tyco).
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Hydra-Zorb Company.
 - e. Thomas & Betts - Superstrut line.
 - f. Tolco (division of Cooper B-Line).
 - 2. Adjustable Swivel Band Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Cooper B-Line).
 - 3. Clevis Hangers:
 - a. Cooper B-Line.
 - b. Anvil International.
 - c. Carpenter & Paterson.
 - d. Tolco (division of Cooper B-Line).
 - 4. J-Hangers:
 - a. Cooper B-Line.
 - b. Carpenter & Paterson.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Cooper B-Line).
 - e. Unistrut (division of Tyco).
 - 5. Cushion Clamps:
 - a. Hydra-Zorb Company.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Cooper B-Line).
 - e. Unistrut (division of Tyco).
 - 6. Insulated Pipe Couplings:
 - a. Cooper B-Line - Armafix line.
 - b. Klo-Shure Corporation.
 - 7. No substitutions.
- B. Horizontal Piping Supports: Provide struts for trapeze hangers for single or multiple pipes. Where individual piping runs are hung with individual hangers, adjustable swivel band hangers, clevis hangers, or j-hangers may be used.
- C. Strut hangers shall be standard 1-5/8 inches x 1-5/8 inches (41x41 mm) size.

- D. Hangers, clamps, and supports located outdoors or otherwise exposed to weather, or in wet or washdown areas, shall be hot-dipped galvanized steel or 300-series stainless steel. Struts may be extruded aluminum. Threaded rods, nuts, and washers may have standard galvanizing if hot-dipped galvanized is not available.
 - 1. Hot-dipped galvanized steel shall have a nominal zinc coating of 2.6 mil (0.066 mm) thickness and 1.5 oz./sq.ft (458 g/m²) coating weight.
 - 2. In lieu of galvanizing, strut systems and their accessories may have Unistrut Perma-Green III electrodeposited thermoset acrylic coating, or be epoxy-coated equal to B-Line's Dura-Green or Dura-Copper coatings.
 - 3. Lesser coatings for struts and clamps, such as pre-galvanizing (0.75 mil (0.019 mm) thickness), electroplated zinc (0.2 to 0.5 mil (0.005 to 0.013 mm) thickness), and yellow zinc dichromate coating, are not acceptable in these locations.
- E. Pipe hanger rods and nuts shall be plated to match the hangers. Nuts shall be self-locking type, or provide double nuts tightened to lock together. Rods shall be threaded one end, or continuous threaded. Provide washers at each nut.
- F. Cushion Clamps for Un-insulated Lines: Plastic cushion shall be Dupont Hytel plastic, 5555HS plastic elastomer, warranted from -40 to 275 degrees F (-40 to 135 degrees C).
- G. Copper-plated hangers are plated for identification only. Traditional thin copper plating on steel substrate does not provide adequate protection from galvanic corrosion due to contact between dissimilar metals.
 - 1. Where copper-plated supports are specified for use with copper piping, either copper plating or a copper-colored finish such as Cooper B-Line's Dura-Copper epoxy coating is acceptable. This is for identification, and does not protect dissimilar metals.
 - 2. Where copper piping is used with steel hangers and supports, provide protection from galvanic corrosion such as thick plastic or vinyl factory coating, or plastic-lined cushion clamps.
- H. For Insulated Lines Clamped to Strut: Insulated pipe coupling insert with the same thickness as the insulation. Protects insulation from crushing, and provides continuous insulation and vapor barrier thru the hanger or clamp. Klo-Shure product provides plastic pipe support and rigid outer band, for field insulation into the coupling. Armafix product provides insulation with rigid outer band, for field insulation glued to the ends of the insert.

2.2 PIPE SUPPORTS

- A. Hydronic Piping:
 - 1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 inches (50 mm) and Over: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 5 inches (125 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
 - 8. Wall Support for Pipe Sizes to 3 inches (76 mm): Cast iron hook.

9. Wall Support for Cold Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 5 inches (125 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.3 FLASHING

- A. Metal Flashing: 26 ga (0.5 mm) thick galvanized steel.
- B. Metal Counterflashing: 22 ga (0.8 mm) thick galvanized steel.
- C. Lead Flashing:
 1. Waterproofing: 5 lb/sq ft (24.5 kg/sq m) sheet lead
 2. Soundproofing: 1 lb/sq ft (5 kg/sq m) sheet lead.
- D. Flexible Flashing: 47 mil (1.2 mm) thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 ga (0.8 mm) minimum; 16 ga (1.5 mm) at fire resistant elements.

2.4 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 ga (1.2 mm) thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 ga (1.2 mm) thick galvanized steel.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Round Ductwork: Galvanized steel.
- E. Sleeves for Rectangular Ductwork: Galvanized steel.
- F. Stuffing or Firestopping Insulation: Glass fiber type, non-combustible.
- G. Sealant: Acrylic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as scheduled.
- B. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
- C. Place hangers within 12 inches (300 mm) of each horizontal elbow.
- D. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Refer to Division 09 Section "Painting". Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Do not support pipes from other pipes or equipment.
- M. Size pipe hangers to accommodate continuous piping insulation.

3.3 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
- B. Flash pipes projecting 3 inches (75 mm) minimum above finished roof surface with lead, 8 inches (200 mm) minimum clear on sides with 24 x 24 inches (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, counterflash with metal, and seal.
- C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
- D. Provide curbs for mechanical roof installations 14 inches (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above

roof jacks. Screw vertical flange section to face of curb.

3.4 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors 1 inch (25 mm) above finished floor level. Caulk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- E. Install chrome plated steel escutcheons at finished surfaces.

3.5 SUPPORTING OTHER TRADES

- A. Supports furnished under Division 23 of the Specifications may also be used to support piping furnished under Division 22 "Plumbing" and conduits furnished under Division 26 "Electrical" if this Subcontractor is willing to allow this. Supports shared with other trades shall be designed to accommodate the weight, expansion/contraction, vibration, and other requirements of the other trades' items without detriment to the function, accessibility, and serviceability of the HVAC items or those of the other trades. Provide flexible sections of piping and conduit as required to allow each trade's items to expand and contract along with the other trades, and to absorb vibration caused by the other trades.
- B. Electrical lighting fixtures and equipment, and architectural items such as ceilings, may not be supported from supports furnished under this Section.
- C. Prevent contact between components of other trades, such as architectural suspended ceiling support wires, and HVAC supports which may transmit vibration to the occupied space.

3.6 SCHEDULES

PIPE SIZE		HANGER ROD MAX. HANGER SPACING		DIAMETER	
Inches	(mm)	Feet	(m)	Inches	(mm)
Copper Piping					
1/2 to 1-1/4	12 to 32	6.5	2	3/8	9
1-1/2 to 2	38 to 50	10	3	3/8	9
2-1/2 to 3	62 to 75	10	3	1/2	13
4 to 6	100 to 150	10	3	5/8	15
8 to 12	200 to 300	14	4.25	7/8	22
14 and Over	350 and Over	20	6	1	25

END OF SECTION 230529

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SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Ceiling Tacks.
- D. Labels.
- E. Stencils.
- F. Pipe Markers.
- G. Lockout Devices.

1.2 RELATED SECTIONS

- A. Division 09 Section “Painting”: Identification painting.

1.3 REFERENCES

- A. Division 01: Requirements for references and standards.
- B. ASME A13.1 - Scheme for the Identification of Piping Systems (2007 edition or newer).
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- D. NFPA 99 - Standard for Health Care Facilities.

1.4 SUBMITTALS

- A. Division 01 Section “Submittal Procedures.”
- B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Samples: Submit 2 tags, 1-1/2 inches (38 mm) in size.
- F. Samples: Submit 2 labels, 1.9 x 0.75 inches (48 x 19 mm) in size.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under Division 01 Section "Closeout Procedures."
- B. Record actual locations of tagged valves; include valve tag numbers.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01.
- B. Include valve tag chart.

1.7 REGULATORY REQUIREMENTS

- A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Seton Identification Products.
 - 2. E.R. Perry Signs & Engraving.
 - 3. Brimar Industries, Inc., PipeMarker division.
 - 4. No substitutions.
- B. Plastic Nameplates: Laminated 3-layer plastic with beveled edges and engraved letters on contrasting background color, 1/16 inch (1.58 mm) thick. Letters shall be black on light backgrounds, or white on dark backgrounds, as applicable. Service temperature range -40 to 175 degrees F (-40 to 79 degrees C); minimum application temperature for adhesive 50 degrees F (10 degrees C). Suitable for average outdoor lifespan of at least 2-3 years.
- C. Aluminum Nameplates: For higher temperature applications, and for outdoor applications when manufacturer does not recommend their plastic nameplates for use outdoors, provide aluminum nameplates, with integral anodized or painted surface color coating and natural aluminum engraved letters, 1/32-inch (0.78 mm) thick. Service temperature range -40 to 350 degrees F (-40 to 177 degrees C); minimum application temperature for adhesive 50 degrees F (10 degrees C). Suitable for average outdoor lifespan of at least 2-3 years.
- D. Colors: Select background color as appropriate for the application. Color for general applications shall be white (except that aluminum nameplate standard color shall be black). Color for general warnings shall be red or yellow. Colors for fluid services shall comply with ASME A13.1-2007. Comply with ASME/ANSI standards and other regulations as applicable.
- E. Provide with factory adhesive, and with side holes for fastener attachment as applicable. Mechanical fasteners are required for applications which are outdoors or otherwise exposed to weather or sunlight, or in moist areas such as kitchens and locker rooms, or on cooled surfaces subject to condensation, or on surfaces with operating temperatures above 150 degrees F (65 degrees C). Where nameplate is on an irregular surface and cannot make complete contact,

provide mechanical fasteners or ties in addition to adhesive.

2.2 TAGS

A. Plastic Tags:

1. Manufacturers:
 - a. Seton Identification Products.
 - b. E.R. Perry Signs & Engraving.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches (38 mm) diameter.

B. Metal Tags:

1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
2. Brass with stamped letters; tag size minimum 1-1/2 inches (38 mm) diameter with smooth edges.

C. Information Tags:

1. Manufacturer: Seton Identification Products.
2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches (83 x 143 mm) with grommet and self-locking nylon ties.

D. Tag Chains and Hooks: Brass or stainless steel compatible with tag material for general applications. Brass where in contact with copper piping or other copper-alloy materials.

E. Tag Chart: Typewritten letter size list in anodized aluminum frame with plexiglass cover.

2.3 CEILING DOTS WITH LABEL-MAKER LABELS

A. Ceiling Dots:

1. Manufacturer: Avery – Division of Avery Dennison Corporation.
2. Description: Self-adhesive 1/2 inch (12.7 mm) diameter color coded label.

B. Label-Maker Labels:

1. Label Maker:
 - a. Manufacturer:
 - 1) Brother.
 - 2) Brady.
 - 3) Dymo.
 - b. Label width capacity: Maximum tape width at least 3/4 inch (19 mm).
 - c. Technology: Thermal transfer.
2. Labels:
 - a. Color:
 - 1) Clear with black lettering for white or off-white ceiling grids.
 - 2) White with black lettering for dark-colored or metallic-colored ceiling grids.

- b. Width:
 - 1) 3/4 inch (18 mm) for standard 15/16 inch (23.8 mm) wide ceiling grids.
 - 2) 1/2 inch (12 mm) for narrow 9/16 inch (14.3 mm) wide ceiling grids.
- c. Lettering Height: Maximum size available, for ease of viewing from floor.
Typical sizes as follows:
 - 1) 36 point (1/2 in. (12 mm)) on 3/4 inch (18 mm) wide labels.
 - 2) 24 point (1/3 in. (8 mm)) on 1/2 inch (12 mm) wide labels.

- C. Color code as follows:
 - 1. HVAC Equipment: Yellow.
 - 2. Fire Dampers/Smoke Dampers: Red.
 - 3. Plumbing Valves: Green.
 - 4. Heating/Cooling Valves: Blue.

2.4 LABELS

- A. Manufacturer: Seton Identification Products.
- B. Description: Polyester, size 1.9 x 0.75 inches (48 x 19 mm), adhesive backed with printed identification.

2.5 STENCILS

- A. Manufacturers:
 - 1. Seton Identification Products.
 - 2. Brimar Industries, Inc., PipeMarker division.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inch (51 mm) Outside Diameter of Insulation or Pipe: 1/2 inch (13 mm) high letters.
 - 2. 2-1/2 to 6 inches (64-150 mm) Outside Diameter of Insulation or Pipe: 1 inch (25 mm) high letters.
 - 3. Over 6 inches (150 mm) Outside Diameter of Insulation or Pipe: 1-3/4 inches (44 mm) high letters.
 - 4. Ductwork and Equipment: 1-3/4 inches (44 mm) high letters.
- C. Stencil Paint: As specified in Division 09 Section "Painting", semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.6 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
 - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

- C. Plastic Underground Pipe Markers:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
 - 2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

2.7 LOCKOUT DEVICES

- A. Lockout Hasps:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Master Lock.
 - 2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches (184 x 76 mm).
- B. Valve Lockout Devices:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Master Lock.
 - 2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 09 Section "Painting" for stencil painting.

3.2 INSTALLATION

- A. Division 01: Manufacturer's instructions.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic or aluminum engraved nameplates with corrosion-resistant mechanical fasteners, or adhesive, as specified. In outdoor locations, where lifetime of nameplates is limited, fasteners shall be removable screws or bolts for ease of nameplate replacement.
- D. Install labels with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain. Number tags consecutively by location.
- F. Apply stencil painting in accordance with Division 09 Section "Painting."

- G. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
- H. Identify items of mechanical equipment such as chillers, fans, terminal units, air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- I. Identify control panels and major control components outside panels with plastic nameplates.
- J. Identify valves in main and branch piping with metal tags.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.
- L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch (20 mm) diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet (6 m) on straight runs including risers and drops, at each branch and riser take-off, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- M. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- N. Identify duct access doors at fire dampers, smoke dampers, and smoke detectors with 1/2 inch (12.7 mm) lettering to indicate the fire protection device(s) within, in accordance with NFPA 90A.
- O. Provide ceiling dots with label-maker labels to locate valves, dampers and equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
- P. Secure valve tag chart on an easily accessible wall in the mechanical room or in a location as otherwise directed by the Architect.

3.3 COORDINATION WITH EXISTING EQUIPMENT

- A. Where an existing equipment identification system is involved, the new system shall be coordinated and compatible with the existing system.

END OF SECTION 230553

SECTION 230593 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, Adjustment, and Balancing of Air Systems.
- B. Testing, Adjustment, and Balancing of Hydronic Piping Systems.
- C. Measurement of Final Operating Condition of HVAC Systems.

1.2 RELATED SECTIONS

- A. Division 01: Testing laboratory services: Employment of testing agency and payment for services.
- B. Division 01 Section “General Commissioning Requirements.”

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing.

1.4 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
- C. NEBB: National Environmental Balancing Bureau.
- D. SMACNA: Sheet Metal and Air Conditioning Contractors’ National Association.
- E. TAB: Testing, Adjusting, and Balancing.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”

- B. Submit name of TAB Agency for approval within 14 days after award of Contract.
- C. Design Review Reports:
 1. Submit prior to commencement of construction under provisions of Division 01.
 2. Review the Contract Documents, and indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- D. Preliminary Report Submittals:
 1. Prior to commencing work of this Section, and no more than 14 days after approval of TAB Agency submittals, submit report forms or outlines indicating adjusting, balancing, and equipment data required, with columns of design data filled in. By means of plan views, equipment profiles, and similar graphical descriptions, indicate where measurements will be taken.
 2. Submit the procedures to be used.
- E. Field Reports: Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
- F. Provide reports in letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- G. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
- H. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, or NEBB forms, or forms containing information indicated in Schedules.

1.6 QUALITY ASSURANCE

- A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance; or ASHRAE 111; or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.7 QUALIFICATIONS

- A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum 3 years' experience and certified by AABC or NEBB, or equivalent experience which would qualify for membership in these testing organizations. Agency shall be one of those listed under article 3.1 AGENCIES in this Section
- B. Perform Work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, or registered Professional Engineer experienced in performance of this Work and licensed at the place where the Project is located.
- C. The approved Agency shall be in no way affiliated with the installing Subcontractor.

1.8 SEQUENCING

- A. Sequence work under the provisions of Division 01.
- B. Sequence work to commence after completion of systems or portions of work, and schedule completion of work before Substantial Completion of Project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 AGENCIES

- A. Tekon Technical Consultants, Portsmouth, NH. Contact: Charles Corlin, (603) 335-3080.
- B. Maine Air Balance, Brewer, ME. Contact: Ron Vaillancourt Tel. (207) 989-0533.
- C. Central Air Balance, Lisbon Falls, Maine 04252; (207) 353-2006; C (207) 754-2023; Contact Glenn Hill.
- D. Hood T.A.B. LLC, Andover, MA. Contact: Michael Hood, (978) 474-7595.
- E. NETB Associates LLC, East Kingston, NH. Contact: Frank Collamore, (978) 270-7547.
- F. No Substitutions.

3.2 EXAMINATION

- A. Verify that systems are complete and operating correctly in accordance with sequence of operations before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place.
 - 15. Service and balance valves are open.
- B. Submit field reports. Report to the responsible Subcontractors, defects and deficiencies noted during performance of services which prevent system balance. Submit list of locations where the Contractor needs to provide additional balancing devices.

- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.4 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- G. Provide system schematic (in floor-plan or line-diagram view) with outlets and inlets numbered with the reference numbers used in the TAB Agent's tabular data, and with required and actual

air quantities recorded at each outlet or inlet.

1. Indicate locations of duct traverses.
 2. Indicate locations of duct pressure sensors, airflow monitoring stations, and other devices which require measurements for control settings.
- H. Measure static air pressure conditions on air supply units, air return units, exhaust units, and heat recovery units, including pressure drops across filters, coils, dampers, mixing boxes, and heat recovery devices, and total pressure across the fan. Make allowances for 50 percent loading of filters, and indicate actual filter drop as well as the allowances. Provide equipment diagram indicating internal components and measurement points.
- I. Provide duct traverse diagrams with measurement points indicated, with readings recorded at each point, and with calculated velocity and airflow.
- J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions. Adjust at minimum position and maximum position, and use manual dampers and actuator limit stops to minimize differences.
- K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- L. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing.

3.8 VERIFICATION OF DUCT LEAKAGE TESTING

- A. The TAB Agent shall witness the duct leakage tests performed under Division 23 Section "HVAC Ducts." At a minimum, the first duct leakage test shall be witnessed and approved by the TAB Agent and the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the TAB Agent. The TAB Agent shall confirm proper testing procedures and shall give written approval to leakage tests. If deficiencies are discovered, the TAB Agent shall document these deficiencies to the Contractor and the Engineer. Once deficiencies are corrected, the TAB Agent shall witness follow-up leakage tests.

3.9 PROJECT CLOSEOUT

- A. Check and adjust systems approximately 6 months after final acceptance and submit report.

3.10 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Packaged Roof Top Heating/Cooling Units
- B. Report Forms:
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone number of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
 - 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 - 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
 - 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
 - 5. Variable Frequency Drive (VFD):
 - a. Motor(s) served
 - b. Manufacturer
 - c. Model/Frame
 - d. HP/BHP ratings
 - e. Phase, voltage, amperage; nameplate, actual, no load

- f. Input and output frequency (Hz)
 - g. Reference speed command from control system
 - h. Carrier frequency setting
 - i. Speeds programmed out for vibration
 - j. Speed adjustment for motor balancing (if allowed)
6. Air Moving Equipment:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Component pressure drops
 - m. Sheave Make/Size/Bore
 - n. Number of Belts/Make/Size
 - o. Fan RPM
7. Return Air/Outside Air Data:
- a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
8. Exhaust Fan Data:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
9. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area

- d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
10. Air Monitoring Station Data:
- a. Identification/location
 - b. System
 - c. Size
 - d. Area
 - e. Design velocity
 - f. Design air flow
 - g. Test velocity
 - h. Test air flow
11. Flow Measuring Station:
- a. Identification/number
 - b. Location
 - c. Size
 - d. Manufacturer
 - e. Model number
 - f. Serial number
 - g. Design Flow rate
 - h. Design pressure drop
 - i. Actual/final pressure drop
 - j. Actual/final flow rate
 - k. Station calibrated setting
12. Air Distribution Test Sheet:
- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow

END OF SECTION 230593

SECTION 230713 – DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Duct Liner.
- C. Fire Resistive Duct Wrap for Kitchen Grease Exhaust.
- D. Insulation jackets.

1.2 RELATED SECTIONS

- A. Division 07: Installation and finishing of outdoor insulation jacket.
- B. Division 09 Section “Painting”: Painting insulation jackets.
- C. Division 23 Section “Identification for HVAC Piping and Equipment.”
- D. Division 23 Section “HVAC Ducts”: Factory-insulated flexible ductwork.
- E. Division 23 Section “HVAC Ducts”: Ductwork.

1.3 REFERENCES

- A. Division 01 Section “References”: Requirements for references and standards.
- B. ASTM
- C. ISO 6944 - 1985 - Fire Resistance Tests - Ventilation Ducts.
- D. NAIMA - National Insulation Standards.
- E. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- F. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- G. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- H. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Division 01 Section “Submittal Procedures”.

- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.
- B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches (50 mm).
- B. Insulation materials shall be asbestos free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01: Transport, handle, store, and protect products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Division 01: Environmental conditions affecting products on site.
- B. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- C. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Glass and Mineral Fiber Products:
 1. Knauf Insulation.
 2. Certainteed Corporation.
 3. Johns Manville.
 4. Owens Corning.
 5. No substitutions.

- B. Elastomeric Foam Products:
 1. Armacell LLC.
 2. K-Flex USA.
 3. No substitutions.

- C. Fire-resistive Duct Blankets for Kitchen Grease Exhaust:
 1. 3M Company – Fire Barrier Duct Wrap 615+.
 2. Thermal Ceramics Inc. – FireMaster FastWrap XL.
 3. Unifrax Corporation – FyreWrap Elite 1.5.
 4. No substitutions.

- D. Glass Fiber Insulation Sealing Tapes:
 1. Venture Tape Corporation.
 2. 3M Company.
 3. Ideal Tape Co., division of American Biltrite Inc.
 4. Nashua Tape Products, division of Berry Plastics Corp.
 5. No substitutions.

- E. Accessories:
 1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
 2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
 3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket systems).
 4. Pabco/Childers Metals, division of ITW Insulation Systems (products: metal jacket systems, and accessories).
 5. Vac Systems International (product: Tough Coat acrylic polymer mechanical insulation repair coating).
 6. Venture Tape Corporation (product: Jacket for outdoor insulation).

2.2 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible blanket.
 1. 'K' ('Ksi') value: ASTM C518, 0.25 at 75 degrees F (0.039 at 24 degrees C).
 2. Maximum service temperature: 250 degrees F (121 degrees C) faced and 350 degrees F (176 degrees C) unfaced.
 3. Maximum moisture absorption: 0.20 percent by volume.
 4. Minimum density: 1.0 lb/cu. ft. (16 kg/m³).

- B. Vapor Barrier Jacket:
 1. ASTM C1136, Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier film. Facing as required for the application. Integral staple flap on one edge.
 - a. Aluminum Faced: FSK (aluminum foil-scrim-kraft) construction.
 - b. White Faced: PSK (polypropylene-scrim-kraft) construction.
 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
 4. Overlap longitudinal laps and butt strips.
 5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.

- C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.

- D. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- E. Tie Wire: Annealed steel, 16 ga (1.5 mm).

2.3 GLASS FIBER, RIGID

- A. Insulation: ASTM C612; rigid, noncombustible blanket. Supplied in board form.
 - 1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75 degrees F (0.036 at 24 degrees C).
 - 2. Maximum service temperature: 450 degrees F (232 degrees C).
 - 3. Maximum moisture absorption: 1.0 percent by volume.
 - 4. Density: 3.0 lb/cu. ft. (48 kg/cu m).
- B. Vapor Barrier Jacket:
 - 1. ASTM C1136, kraft paper reinforced with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
 - a. Aluminum Faced: FSK (foil-scrim-kraft) construction
 - b. White Faced: ASJ (all-service jacket) construction.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 - 3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
 - 4. Overlap longitudinal laps and butt strips.
 - 5. Secure insulation with mechanical fasteners to substrate, and seal jacket with pressure sensitive tape.
- C. Vapor Barrier Tape: See article "Glass Fiber Insulation Sealing Tape" in this Section.
- D. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.4 GLASS FIBER, SEMI-RIGID

- A. Insulation: ASTM C612; semi-rigid, noncombustible blanket, with fibers oriented perpendicular to insulation surface to provide compressive strength while maintaining flexibility. Supplied in roll form, suitable for application on rounded shapes such as pipes, tanks, ducts, vessels, and other similar round and irregular shapes.
 - 1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75 degrees F (0.036 at 24 degrees C).
 - 2. Maximum service temperature: 450 degrees F (232 degrees C).
 - 3. Maximum moisture absorption: 1.0 percent by volume.
 - 4. Density: 2.5 lb/cu. ft. (40 kg/cu m).
- B. Vapor Barrier Jacket:
 - 1. ASTM C1136, kraft paper with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
 - a. Aluminum Faced: FSK (foil-scrim-kraft) construction
 - b. White Faced: ASJ (all-service jacket) construction.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 - 3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
 - 4. Overlap longitudinal laps and butt strips.
 - 5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.

- C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.
- D. Indoor Vapor Barrier Finish:
 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.5 GLASS FIBER INSULATION SEALING TAPE

- A. Self-adhesive tape with integral vapor barrier, pressure sensitive acrylic-based or rubber-based adhesive, and release liner strip. Width 3 inch (76 mm) nominal.
- B. Manufactured by VentureTape, by the insulation manufacturer, or by one of the other tape manufacturers listed in the article “Manufacturers” in this Section.
- C. Types:
 1. For rigid and semi-rigid insulations, tape shall be reinforced type. For flexible “duct wrap” insulation, tape shall be either reinforced or non-reinforced.
 2. White or aluminum outer surface to match the insulation.
 3. Reinforced: Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier layer.
 - a. Aluminum Finish with FSK: VentureTape 1525CW.
 - b. White Finish with ASJ: VentureTape 1540CW
 - c. White Finish with PSK: VentureTape 1531CW.
 4. Non-Reinforced: Foil insulation tape. Dead-soft temper 2 mil (0.05 mm) thick aluminum foil, without reinforcement. Hand-tearable.
 - a. Venture Tape 3520CW.
 5. Performance:
 - a. Peel Adhesion: PSTC-101 with 20 minute dwell, 45 oz/in. (12.5 N / 25 mm).
 - b. Shear Adhesion: PSTC-107, 2.2 psi (15.2 kPa) after 24 hours.
 - c. Tensile Strength: PSTC-131:
 - 1) Reinforced Types: 40 lb/in. (180.8 N / 25 mm).
 - 2) Non-reinforced Types: 21 lb/in. (94.9 N / 25 mm).
 - d. Elongation: PSTC 131, 6 percent maximum.
 - e. Service Temperature: -40 to 240 degrees F (-40 to 116 degrees C).
 - f. UL 723 listed or classified (flame/smoke rating).

2.6 ELASTOMERIC FOAM DUCT LINER

- A. Products:
 1. Armacell, AP Armaflex and AP Armaflex FS black or gray sheet duct liner insulation.
 2. K-Flex USA: Insul-Sheet S2S and K-Flex LS sheet insulation.
 3. No substitutions.
- B. Insulation: ASTM C534; flexible cellular elastomeric foam, molded or sheet, factory-treated with antimicrobial agent.
 1. 'K' ('Ksi') value: ASTM C177; 0.25 Btu-in/(h-ft²-degrees F) at 75 degrees F (0.04 W/m-K at 24 degrees C).
 2. Minimum service temperature: -70 degrees F (-57 degrees C) (flexible to -40 degrees F (-40 degrees C)).
 3. Maximum service temperature: 180 degrees F (82 degrees C).
 4. Maximum moisture absorption: ASTM C209, 0.2 percent by volume; or ASTM D1056,

- 5 percent by weight.
- 5. Moisture vapor transmission: ASTM E96; 0.20 perm-inches (1.16x10⁻¹⁰ Kg/(s-m-Pa)).
- 6. Maximum velocity on airstream side: ASTM C1071; 6,000 fpm (30.5 m/sec).
- 7. Connection: Waterproof vapor barrier adhesive.
- 8. Density: 3.0 to 6.0 lb/cu. ft. (48 to 96 kg/cu m).
- 9. Minimum sound absorption coefficients, ASTM C423, Type A mounting (sabins/sq. ft):
 - a. At 250 Hz center band frequency: 0.17 for 1 inch (25 mm) thickness.
 - b. At 500 Hz center band frequency: 0.80 for 1 inch (25 mm) thickness.
 - c. At 1000 Hz center band frequency: 0.32 for 1 inch (25 mm) thickness.
 - d. NRC: 0.50 for 1 inch (25 mm) thickness.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. Self-Adhesive Coating: At the Contractor's option, the insulation may be provided with a factory-applied self-adhesive coating with peel-off release liner. If the Manufacturer recommends installation of self-adhesive liner without mechanical pin fasteners at all velocities, the pins may be omitted. Provide suitable cleaner for the ductwork to ensure adhesion.

2.7 FIRE RESISTIVE DUCT WRAP

- A. General:
 - 1. Work includes labor, material, and equipment to provide 2 hour fire resistive rated grease or air duct enclosure as a shaft alternative and a method for providing zero-inch clearances around commercial kitchen grease duct exhaust systems to combustible materials.
 - 2. These Specifications are based on 3M Fire Barrier Duct Wrap 615+ materials. Where installation requirements of substituted products differ from these Specifications, the more stringent requirements shall apply.
- B. Listing Agency: Provide products that are listed by at least one the following:
 - 1. Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory" category XHEZ or XHBN as appropriate.
 - 2. Omega Point Laboratories (OPL), in "Directory of Listed Products, Through Penetration Fire Resistance Directory."
 - 3. Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.
- C. Furnish products identical to those tested for classification by listing agency.
- D. Mark product packing with classification marking of listing agency.
- E. Duct Wrap Exposed to View: Provide products with flame spread index of less than 25 and smoke developed index of less than 450, when tested in accordance with ASTM E84.
- F. Duct Wrap Exposed to View, Traffic, Moisture, or Physical Damage: Provide products that after curing do not deteriorate when exposed to those conditions during and after construction.
- G. Materials: Use only products specifically listed for use in Listed systems.
- H. Submittals: Submit test reports substantiating performance requirements and Code compliance along with manufacturer's installation instructions.

- I. Duct Wrap: 3M Fire Barrier Duct Wrap 615+: Lightweight, non-asbestos, high temperature, bio-soluble, calcium-magnesium-silicate (CMS) non-woven blanket, encapsulated in a scrim-reinforced foil, blanket thickness of 1.5 inches (38 mm) for ventilation and grease duct applications.
1. Color: White blanket, aluminum foil encapsulated.
 2. Weight: 0.9 psf (4.38 kg/m²).
 3. Density: 6 pcf (96.1 kg/m³) nominal.
 4. Thermal Conductivity (k-value) at 500 degrees F (260 degrees C) (ASTM C411, ASTM C518): 0.48 Btu/(ft² x h x F) (0.07 W/(m x K)).
 5. R-Value per ASTM C518 at ambient 77 degrees F (25 degrees C): At least 6.3 F-ft²-hr/Btu (1.1 K-m²/W)..
 6. Service range up to 2000 degrees F (1093 degrees C)
 7. Fire Resistance: For use in 1 hour and 2 hour fire resistant systems.
 8. Product complies with ASTM E2336 test standard.
 9. Product complies with ISO 6944 test standard.
 10. Through-penetration per ASTM E814 (UL 1479).
 11. Non-combustible per ASTM E136.
- J. Accessory Materials:
1. Tapes:
 - a. High Performance Filament Tape: 3M tape No. 898, 1inch (25 mm) wide.
 - b. FSK Facing Tape: 3M tape No. 3320, with aluminum foil, fiberglass scrim, and kraft paper backing. Nominal 3 inches (76 mm) wide or 4 inches (102 mm) wide. For sealing cut blanket edges and seams.
 2. Banding Material: Stainless or carbon steel banding, 1/2 inch (13 mm) wide x 0.015 inch (0.4 mm) thick, as stated in duct wrap Design Listing.
 3. Insulation Pins and Clips:
 - a. Copper-coated steel pins, 12 gauge with a minimum length of 4 inches (102 mm), with 2.5 inch (64 mm) square galvanized steel speed clips.
 - b. 12 ga insulated cup head steel pins.
 4. Through-Penetration Fire Stop Materials:
 - a. Packing Material: Scrap pieces of fire resistive duct wrap, 1.5inches (13 mm) thick, or 4 pcf (56 kg/m³) mineral wool.
 - b. Sealant: 3M 2000+ premium non-slump silicone sealant, or other sealant as stated in the duct wrap's Design Listing.
 5. Access Doors: 3M Fire Barrier Grease Duct Access Doors.
 - a. Steel angle opening frame, with threaded holes for fasteners.
 - b. Access cover, minimum 16 ga, with loop handle, labeling, and fastener holes.
 - c. Thumb screws for initial fastening of access cover to frame.
 - d. 3M Fire Barrier Grease Duct Access Door Hardware Extension Kit, including threaded rods, wing nuts, nuts, and washers.
 - e. Outer plate, minimum 16 ga steel, field furnished.
 - f. Layers of fire-resistant duct wrap, sized per manufacturer's instructions, with edges sealed with aluminum foil tape.
 - g. Insulation pins and speed clips to fasten the layers of duct wrap to the inside face of outer steel plate.
 - h. Label for outer plate.
- K. Execution: See Part 3 of this Section.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 01 Section “Project Management and Coordination”: Verification of existing conditions before starting work.
- B. Verify that ductwork has been tested before applying insulation materials.
- C. Verify that surfaces are clean, foreign material removed, and dry.
- D. Verify that insulation materials are clean and dry. Discard any materials that exhibit signs of moisture damage, contamination, mold, mildew, or other biological growth. Discard any materials used in the air handling airstream if they have been exposed to water.

3.2 INSTALLATION

- A. Division 01: Manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Provide insulation for surfaces of ductwork, as indicated and specified. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
- D. Insulated Ductwork Conveying Air below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- E. Insulated Ductwork Conveying Air above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- F. Do not insulate exposed heating or cooling supply ductwork in the conditioned spaces which it serves, unless otherwise specified or indicated on the Drawings.
- G. Wherever exposed ductwork for air conditioned systems passes through non air conditioned spaces, insulate ductwork with glass fiber rigid insulation with vapor barrier, to prevent condensation.
- H. Where rigid glass fiber insulation is scheduled, semi-rigid glass fiber insulation may be used on round and flat oval ducts and irregular shapes, and preformed pipe insulation may be used on small diameter round ducts.
- I. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.

2. Secure insulation without vapor barrier with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

J. Duct and Plenum Liner Application:

1. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.
2. Provide duct liner where:
 - a. Indicated on the Drawings.
 - b. Specified.
3. Install duct liner in accordance with SMACNA standards.
4. Install elastomeric foam duct liner in accordance with manufacturer's recommendations.
5. Adhesive: Apply to duct sheet metal for 90 percent coverage. Clean the duct before applying adhesive.
6. Mechanical Fastening: In addition to adhesive, provide mechanical fastening devices meeting the following requirements:
 - a. Are spaced in accordance with SMACNA Standards and Manufacturer's recommendations.
 - b. When installed, are as corrosion-resistant as G60 coated galvanized steel.
 - c. Will not adversely affect the fire-resistant classification of liner and adhesives.
 - d. Do not damage the liner when applied as recommended by the manufacturer.
 - e. Do not cause leakage in the duct.
 - f. Do not project more than nominally into the airstream.
 - g. Will indefinitely sustain a 50 lb (222 N) tensile dead load test perpendicular to the duct wall.
 - h. Have a permanent, waterproof bond to the duct wall.
 - i. Are the correct length for the specified liner thickness.
7. Self-Adhesive Elastomeric Foam Insulation: If manufacturer's instructions recommend omitting mechanical pin fasteners at all air velocities, they may be omitted. Clean the duct with recommended liquid cleaner before installing insulation.
8. Seal and smooth liner airstream surface penetrations, cuts, tears, edges, and transverse and longitudinal joints with adhesive or acrylic polymer repair coating, compatible with liner surface coating.
9. Corners: Cut and fit liner in the corners of rectangular duct sections to assure butted edge overlapping. Longitudinal joints in duct liner shall not occur except at the corners of ducts unless the size of the duct and standard liner product dimensions make joints necessary.
10. Transverse Joints: Butt liner neatly without gaps.
11. Provide securely-installed metal nosings that are either channel or zee profile or are integrally-formed from the duct wall over transversely oriented liner edges facing the airstream at fan discharge, at access doors, and at any interval of lined duct preceded by unlined duct. In addition, where velocities exceed 2,000 fpm (10.2 mps), provide metal nosing on upstream edges of liner at every transverse joint.
12. Where dampers, turning vane assemblies or other devices are placed inside of lined duct or fittings, install to not damage the liner or cause erosion of the liner. The use of metal hat sections or other buildout means is optional; when used, secure buildouts to the duct wall with bolts, screws, rivets or welds.

- 13. Do not install duct liner in fresh air intake ductwork between the outside intake opening and the fan or other air moving device, or within 10 feet (3 m) downstream of a cooling coil or humidifier.
- K. Inspection Plates and Test Holes: Provide, where required, in ductwork or casings for balance measurements. Test holes shall be factory fabricated, airtight, and noncorrosive with screw cap and gasket. Extend cap through insulation.
- L. Install insulation after ductwork and equipment have been tested and approved.
- M. Ensure that surface is clean and dry prior to installation. Ensure that insulation is dry before and during application. Finish with system at operating conditions.
- N. Ensure that insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material, properly sealed.
- O. Finish insulation neatly at hangers, supports and other protrusions.
- P. Locate insulation or cover seams in least visible locations.
- Q. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.
- R. Standing seams, supporting angles and flanges on insulated ductwork shall be insulated with thickness equal to the duct and edges shall be finished and vapor sealed.
- S. For supply or return ductwork which is required to be insulated, insulation shall be continuous and shall include the insulating of register, grille and diffuser connection plenums/boots.
- T. Mechanical fasteners shall not be riveted or screwed to the duct and shall not penetrate the metalwork.

3.3 FIRE RESISTIVE DUCT WRAP

- A. Install duct wrap system in accordance with manufacturer's instructions and referenced standards.
- B. Install duct wrap in direct contact with the duct it encloses. Install in accordance with details of the product's Listing. Protect every portion of duct with no less than 2 layers. Overlap both perimeter and longitudinal joints minimum of 3 in. (76 mm) per layer of material. If required, tape seams using minimum 3 in. (76 mm) wide aluminum foil self-adhesive tape.
- C. Air Duct Enclosure Wrap: Follow same traditional wrap method with exception of utilizing a 3 in. (76 mm) perimeter overlap in conjunction with longitudinal butt joint wrap plus duct wrap collar over exterior layer joints.
- D. Filament tape may be used as a temporary securing measure on both layers until banding hardware is in place. Band exterior layer spaced no more than 10.5 in. (267 mm) on center, and within 1.5 in. (39 mm) of overlapped seams.
- E. For duct widths greater than 24 inches (610 mm), weld insulation pins to bottom of horizontal

and outer vertical duct runs. Space on a grid in accordance with duct wrap manufacturer's instructions. Impale duct wrap over pins and secure with galvanized steel speed clips before banding is applied.

- F. Protect grease duct access doors with 3 layers of duct wrap, each layer overlapping previous by 1 inch (25 mm) on all sides and in accordance with manufacturer's instructions.
- G. Where fire rated duct wrap is used as a shaft enclosure, firestop at fire separations in accordance with the duct wrap manufacturer's recommendations.
- H. Protect fire wrap from damage when installed in locations accessible to building occupants.
- I. Repair Procedure:
 1. Repair damaged duct wrap in accordance with manufacturer's instructions.
 2. Remove damaged section. Apply a new section of same dimension. Place and fit ensuring same overlap that existed previously. Place banding around new duct wrap material and tension to sufficiently hold in place.
 3. If damage has penetrated to interior layer, remove affected sections and reinstall as specified in Installation.

3.4 PAINTING AND IDENTIFICATION

- A. Paint in accordance with Division 09 Section "Painting."

3.5 FIELD INSPECTION

- A. Visually inspect to ensure that materials used conform to Specifications. Inspect installations progressively for compliance with requirements.

TABLE I
DUCTWORK INSULATION MATERIAL AND WALL THICKNESS

DUCTWORK TYPE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS
Supply ductwork (unless exposed in a conditioned space)	Glass Fiber, Flexible	Yes	1 ½ inches (38.1 mm)
	Glass Fiber, Rigid	Yes	1 ½ inches (38.1 mm)
Exposed supply ductwork in mechanical or equipment rooms	Glass Fiber, Rigid	Yes	1 ½ inches (38.1 mm)
Ductwork located outdoors, including above roofs	Polyisocyanurate Foam Board, Rigid, with Waterproof Jacket	Yes	2 layers of 1 ½ inch (38.1 mm) with staggered joints
Supply, return and exhaust ductwork in cold attic spaces, crawl spaces or any space outside of the building insulation envelope but within the building shell and protected from weather	Glass Fiber, Flexible	Yes	2 layers of 1 ½ inches (38.1 mm) with staggered joints
	Glass Fiber, Rigid	Yes	2 layers of 1 ½ inches (38.1 mm) with staggered joints

DUCTWORK TYPE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS
Exhaust ductwork from exterior building openings (such as louvers and roof hoods) to 4 feet (1.2 m) interior of motorized damper or backdraft damper.	Glass Fiber, Flexible (only if ductwork is concealed)	Yes	1 ½ inches (38.1 mm)
	Glass Fiber, Rigid	Yes	1 ½ inch (38.1 mm)
Outside air intake ductwork	Glass Fiber, Flexible (only if ductwork is concealed)	Yes	2 layers of 1 ½ inch (38.1 mm) with staggered joints
	Glass Fiber, Rigid	Yes	2 layers of 1 ½ inch (38.1 mm) with staggered joints
Mixed air ductwork	Glass Fiber, Flexible (only if ductwork is concealed)	Yes	2 layers of 1 ½ inches (38.1 mm) with staggered joints
	Glass Fiber, Rigid	Yes	2 layers of 1 ½ inches (38.1 mm) with staggered joints
Ductwork 10 feet upstream and downstream from a supply or return fan, or through the first elbow, whichever is longer (excluding fresh air intake ductwork)	Elastomeric Foam Duct Liner	--	1 inch (25.4 mm)
Ductwork indicated on Drawings or specifications to be acoustically lined	Elastomeric Foam Duct Liner	--	1 inch (25.4 mm)
Kitchen Hood Grease Exhaust Ductwork near combustible materials and where indicated	Fire Resistive Duct Wrap	---	2 layers of 1-1/2 inches (38.1 mm) with staggered joints per Manufacturer's Recommendations to achieve zero clearance to combustibles
Kitchen Hood Grease Exhaust Ductwork where indicated to provide an alternative to a rated shaft enclosure	Fire Resistive Duct Wrap	---	2 layers of 1-1/2 inches (38.1 mm) with staggered joints per Manufacturer's Recommendations to achieve equivalence to a 2-hour rated shaft enclosure.

END OF SECTION 230713

SECTION 230719 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.
- C. Shields, Inserts, and Saddles.

1.2 RELATED SECTIONS

- A. Division 07.
- B. Division 09 Section “Painting”: Painting insulation jacket.
- C. Division 23 Section “Identification for HVAC Piping and Equipment.”
- D. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”: Placement of hangers and hanger inserts.
- E. Division 23 Section “Hydronic Piping”: Placement of hangers and hanger inserts.

1.3 REFERENCES

- A. Division 01: Requirements for references and standards.
- B. ASTM
- C. NAIMA National Insulation Standards.
- D. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- E. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures”.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.
- B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches (50 mm).
- B. Insulation materials and accessories shall be asbestos-free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01: Transport, handle, store, and protect products.
- B. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Division 01: Environmental conditions affecting products on site.
- B. Maintain ambient conditions required by manufacturers of each product.
- C. Maintain temperature before, during, and after installation for minimum of 24 hours.

1.9 EXISTING PIPING

- A. Insulate existing piping as indicated on the Drawings. Contractor shall be responsible to field-verify quantities and sizes. Provide access to existing piping as required for complete insulation. Remove existing finishes and existing insulation as required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Glass and Mineral Fiber Products:
 - 1. Knauf Insulation.
 - 2. Certainteed Corporation.
 - 3. Johns Manville.
 - 4. Owens Corning.
 - 5. No substitutions.

2.2 GLASS FIBER

- A. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' ('Ksi') value: ASTM C177, 0.24 Btu-in/(hr-sq.ft- degrees F) at 75 degrees F (0.035 W/m-K at 24 degrees C).
 - 2. Maximum service temperature: 850 degrees F (454 degrees C).
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- B. Vapor Barrier Jacket:
 - 1. ASTM C1136, White kraft paper with glass fiber yarn, bonded to aluminized film.

- 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
- C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- F. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.
- G. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- H. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- I. Insulating Cement: ASTM C449/C449M.

2.3 JACKETS

- A. PVC Plastic.
- B. Canvas Jacket: UL listed.
 - 1. Fabric: 6 oz/sq yd (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.
 - 2. Lagging Adhesive: Compatible with insulation.
- C. Fibrous Glass Fabric:
 - 1. Cloth: Heat treated to remove most organic binders. May be factory-impregnated with an inorganic fire-retardant rewettable adhesive, at Contractor's option.
 - 2. Weight: 9 oz/sq yd (305 g/sq m) minimum.
 - 3. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
 - 4. Weave: 10x20 per inch (390x780 per meter).
 - 5. Service Temperature: 1000 degrees F (538 degrees C).

2.4 SHIELDS, INSERTS, AND SADDLES

- A. Shields:
 - 1. Carpenter and Paterson Figure 265GS, or equal.
 - 2. Galvanized or electro-galvanized steel, minimum 12 inch length, minimum 120-degree arc, minimum 18 ga.
 - 3. Provide contact adhesive to glue shields to the insulation.
- B. Snap-On Shields:
 - 1. Cooper B-Line "Snap-N Shield".
 - 2. Snap-N Shield is an acceptable substitute for metal shields when installed with strut trapeze hangers on horizontal piping.
 - 3. Paintable polypropylene plastic 12 inch long preformed shields, snap-on design for

- attachment to strut.
 - 4. Gluing is not required with Snap-N Shield.
 - 5. Provide black or white color to match the insulation in areas exposed to public view.
- C. Inserts:
- 1. Configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 2. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- D. Saddles:
- 1. Factory fabricated of curved carbon steel plate, of same overall thickness and contour as adjoining insulation. Sides designed for welding to pipe. Center support plate for pipe sizes 12 inches (300 mm) and larger.

2.5 MANUFACTURER'S STAMP OR LABEL

- A. Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to the project site for use shall have the manufacturer's stamp or label attached giving name of manufacturer, brand, and description of material. Insulation packages and containers shall be asbestos-free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Division 01: Manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards where applicable.
- C. Provide insulation for surfaces of new piping and for surfaces of existing piping that is uninsulated, as indicated and specified.
- D. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, applicable State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
 - 1. International Energy Conservation Code (IECC): Chapter 5 of the Code allows the use of ASHRAE 90.1 insulation thicknesses instead of the Minimum Pipe Insulation table which is in Chapter 5 of the IECC. This Specification does not reference the table in IECC.
- E. Piping systems requiring insulation, types of insulation required, and insulation thickness shall be as listed in Table I herein. For piping not listed in Table 1, insulate to meet Code requirements, using suitable specified materials, subject to Architect's approval. Except for

flexible unicellular insulation, insulation thicknesses as specified in Table I shall be one inch (25 mm) greater for insulated piping systems located outside the building and in unconditioned spaces. Unless otherwise specified, insulate fittings, flanges, and valves, except valve stems, hand wheels, and operators. Use factory pre-molded, pre-cut, or field-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be factory cleanable, grease resistant, non-flaking, and non-peeling.

- F. Exposed Piping: Locate insulation and cover seams in least visible locations.
- G. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.
- H. Glass Fiber Insulated Pipes Conveying Fluids above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- I. For piping which may operate at a range of temperatures (for example, heat recovery and heat exchange piping), provide insulation and vapor barriers as are suitable for the entire range of operation.
- J. Branches to Gauges, Sensors, Drains, and Vents: Insulate branches to gauges, sensors, drains, and vents as for active sections of piping. For piping with operating temperatures above ambient, insulate to at least 6 inches (150 mm) from the active main. For temperature devices, insulate to include the sensing bulb or other element. For pressure devices in hot piping with syphon loops, insulate from the active main to the syphon loop, but it is not necessary to insulate the syphon loop or the portion of the branch on the device side of the syphon loop.
- K. Shields, Inserts, and Saddles:
 - 1. Application: Provide shields at hangers. Provide inserts for piping 2 in. (50 mm) nominal size or larger. Provide saddles for piping 6 in. (150 mm) nominal size and larger and for generator exhaust piping and muffler.
 - 2. Shield location: Between insulation jacket and hanger.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Saddle location: Between support shield and piping.
 - 5. Tack-weld saddles to the pipe or muffler. Fill air spaces within the saddle with insulation material.
 - 6. Glue shields to outside of insulation after system is filled and run at operating temperature.
 - 7. Align mid-length of shields, inserts, and saddles with the hanger centerline.
- L. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Division 07.

3.3 UNIFORM INSTALLATION

- A. Systems shall use a single insulation type throughout the installation.

3.4 PREPARATION

- A. Insulate piping after system tests have been completed and surfaces to be insulated have been cleaned of dirt, rust, and scale and dried. Ensure full range of motion of equipment actuators. Modify insulation to avoid obstruction of valve handles, safety reliefs, and other components requiring movement. Allow adequate space for pipe expansion. Install insulation with jackets drawn tight and cement down on longitudinal and end laps. Do not use scrap pieces where a full length section will fit. Insulation shall be continuous through sleeves, wall and ceiling openings. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at the manufacturer's recommended coverage per gallon. Individually insulate piping. Provide a moisture and vapor seal where insulation terminates against metal hangers, anchors and other projections through the insulation on surfaces for which a vapor seal is specified. Keep insulation dry during the application of any finish. Bevel and seal the edges of exposed insulation. Unless otherwise indicated, do not insulate the following:
1. Piping in radiation enclosures, or within cabinets of unit heaters.
 2. Valve hand wheels.
 3. Fire protection pipes
 4. Vibration isolating connections.
 5. Adjacent insulation.
 6. ASME stamps.

3.5 PIPING INSULATION

- A. Pipe Insulation-Place sections of insulation around the pipe and joints tightly butted into place. The jacket laps shall be drawn tight and smooth. Secure jacket with fire resistant adhesive, factory applied self sealing lap. Cover circumferential joints with butt strips, not less than 3-inches (76 mm) wide, of material identical to the jacket material. Overlap longitudinal laps of jacket material not less than 1-1/2 inches (38 mm). Adhesive used to secure the butt strip shall be the same as used to secure the jacket laps. When a vapor barrier jacket is required, as indicated in Table I, or on the ends of sections of insulation that butt against flanges, unions, valves, fittings, and joints, use a vapor-barrier coating conforming to manufacturer's weatherproof coating for outside service. Apply this vapor barrier coating at longitudinal and circumferential laps. Patch damaged jacket material by wrapping a strip of jacket material around the pipe and cementing, and coating as specified for butt strips. Extend the patch not less than 1-1/2 inches (38 mm) past the break in both directions. At penetrations by pressure gauges and thermometers, fill the voids with the vapor barrier coating for outside service. Seal with a brush coat of the same coating. Where penetrating roofs, insulate piping to a point flush with the top of the flashing and seal with the vapor barrier coating. Butt tightly the exterior insulation to the top of the flashing and interior insulation. Extend the exterior metal jacket 2 inches (51 mm) down beyond the end of the insulation. Seal the flashing and counterflashing underneath with the vapor barrier coating.
- B. Seal surfaces of fibrous insulation to prevent release of fibers.
- C. Sleeves and Wall Chases: Where penetrating interior walls, extend a metal jacket 2 inches (51 mm) out on either side of the wall and secure on each end with a band. Where penetrating floors, extend a metal jacket from a point below the back-up material to a point 10 inches (254 mm) above the floor with one band at the floor and one not more than one inch from end of metal jacket. Where penetrating exterior walls, extend the metal jackets through the sleeve to a point 2 inches (51 mm) beyond the interior surface of the wall.

3.6 PAINTING AND IDENTIFICATION

- A. Paint in accordance with Division 09 Section "Painting". Piping identification shall be as specified in other sections.

TABLE I
PIPING INSULATION MATERIAL AND WALL THICKNESS

SERVICE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS AT THE FOLLOWING PIPE DIAMETERS				
			<1 inch	1 inch to <1.5 inches	1.5 inches to <4 inches	4 inches to <8 inches	8 inches or Greater
Heating Systems (Steam, Steam Condensate, Hot Water Supply and Return)							
Above 350 degrees F	Glass Fiber	No	4.5 inches	5 inches	5 inches	5 inches	5 inches
	Hydrous Calcium Silicate	No	4.5 inches	5 inches	5 inches	5 inches	5 inches
251 degrees F to 350 deg. F	Glass Fiber	No	3 inches	4 inches	4.5 inches	4.5 inches	4.5 inches
201 degrees F to 250 deg. F	Glass Fiber	No	2.5 inches	2.5 inches	2.5 inches	3 inches	3 inches
141 degrees F to 200 deg. F	Glass Fiber	No	1.5 inches	1.5 inches	2 inches	2 inches	2 inches
105 degrees F to 140 deg. F	Glass Fiber	Yes	1 inch	1 inch	1.5 inches	1.5 inches	1.5 inches

END OF SECTION 230719

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SECTION 232113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings For:
 - 1. Heating water piping system.
 - 2. Equipment drains and overflows.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Access Doors.

1.3 RELATED SECTIONS

- A. Division 09 Section “Painting.”
- B. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”
- C. Division 23 Section “Identification for HVAC Piping and Equipment.”
- D. Division 23 Section “HVAC Piping Insulation.”
- E. Division 23 Section “Hydronic Specialties.”

1.4 REFERENCES

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B31.5 - Refrigeration Piping.
- F. ASME B31.9 - Building Services Piping.
- G. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
- H. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- I. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- J. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

- K. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- L. ASTM A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- M. ASTM B32 - Solder Metal.
- N. ASTM B88 - Seamless Copper Water Tube.
- O. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- P. ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- Q. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- R. ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
- S. ASTM D2310 - Machine-Made Reinforced Thermosetting Resin Pipe.
- T. ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- U. ASTM D2467 - Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- V. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite-Sewer Piping.
- W. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- X. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- Y. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- Z. ASTM D3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
- AA. ASTM D3965 - Standard Classification System and Basis for Specifications for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings.
- BB. ASTM F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- CC. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- DD. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- EE. ASTM F2389 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
- FF. ASTM F845 - Plastic Insert Fittings for Polybutylene (PB) Tubing.

- GG. ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
- HH. ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.
- II. AWS A5.8 - Brazing Filler Metal.
- JJ. AWS D1.1 - Structural Welding Code.
- KK. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
- LL. AWWA C110 - Ductile - Iron and Grey -Iron Fittings 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
- MM. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.
- NN. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- OO. CSA B137.11 - Polypropylene (PP-R) Pipe and Fittings for Pressure Applications.
- PP. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
- QQ. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- RR. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- SS. NSF/ANSI 14 – Plastic Piping System Components and Related Materials.
- TT. NSF/ANSI 61 - Drinking Water System Components.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide Manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welder’s certification of compliance with ASME SEC 9 and AWS D1.1.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.
- B. Record actual locations of valves.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years’ experience.
- C. Welders: Certify in accordance with ASME SEC 9 and AWS D1.1.
- D. Pressed Pipe Fittings: Submit documentation of fitting-manufacturer training of installers or their on-site supervisors, with names of individuals.

1.9 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.1 HEATING WATER PIPING, ABOVE GROUND

- A. Copper Tubing: ASTM B88, Type L hard drawn.
 - 1. Allowed only for pipe sizes 2 inch (50.8 mm) and smaller.
 - 2. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 - 3. Joints: Solder or braze

2.2 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder or braze.
- B. PVC Pipe: ASTM D1785, Schedule 40, and Schedule 80 for sizes 8 inch (200 mm) and larger, or ASTM D2241, SDR 21 or 26.
 - 1. Fittings: ASTM D2466, D2665 or D2467, PVC.
 - 2. Joints: ASTM D2855, solvent weld.

2.3 SOLDER MATERIALS:

- A. Manufacturers:
 - 1. Harris (Product: Stay-Brite).
 - 2. Lucas-Milhaupt (Product: Clean 'n Brite).
 - 3. Wolverine (Product: Silvabrite).
 - 4. No substitutions.
- B. Nominal Composition: Alloy of silver and tin (3-6 percent Ag, remainder Sn). Antimony-free.
- C. Physical Properties:
 - 1. Color: Bright Silver
 - 2. Solidus: 430 degrees F (221 degrees C)
 - 3. Liquidus: 430 degrees F (221 degrees C)
 - 4. Electrical Conductivity: 16.4 percent IACS
 - 5. Shear Strength: 10,600 psi (73 MPa)
 - 6. Tensile Strength: 14,000 psi (96 MPa)
 - 7. Elongation: 48 percent
- D. Specification Compliance:
 - 1. NSF 51
 - 2. ASTM B32-89, Alloy Grade Sn96
 - 3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
 - 4. J-STD-006, Sn96Ag04A
- E. Flux:
 - 1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4 inch or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
 - 2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.4 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 inch (50 mm) and Under:
 - 1. Copper Pipe: Bronze, soldered joints.
- B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. Refer to Division 23.

3.2 INSTALLATION

- A. Install in accordance with Manufacturer's instructions.
- B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors furnished under Division 23.
- C. Install heating water, glycol, condenser water, and engine exhaust piping to ASME B31.9. Install chilled water piping to ASME B31.5.
- D. Pipe used shall be new material, and threads on piping shall be full length and clean cut with inside edges reamed smooth to full inside bore.
- E. Minimum pipe size allowed for hydronic piping shall be 3/4 inch (19 mm). Piping less than 3/4 inch (19 mm) shall not be allowed for these piping systems.
- F. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- G. Install piping to conserve building space, and not interfere with use of space.
- H. Group piping whenever practical at common elevations.
- I. Erect piping to provide for the easy passage and noiseless circulation of water under working conditions.
- J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level. Slope water piping 1 inch in 40 feet (1:40) and arrange to drain at low points. Slope piping up in direction of water flow.
- K. On closed systems, equip low points with 3/4 inch (19 mm) drain valves and hose nipples. Provide, at high points of mains, collecting chambers and high capacity float operated automatic air vents, with ball valves on their inlets to valve off after initial system startup. Provide, at high points of branches, manual air vents with air chambers.
- L. Use main sized saddle type branch connections for directly connecting branch lines to mains in steel piping if main is at least 1 pipe size larger than the branch for up to 6 inch (152 mm) mains and if main is at least 2 pipe sizes larger than branch for 8 inch (203 mm) and larger mains. Do

not project branch pipes inside the main pipe.

- M. Caulking of threads will not be allowed on any piping.
- N. Pipe joint compound shall be put on male threads only.
- O. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- P. Dissimilar Metals: Use non-conducting dielectric connections whenever jointing dissimilar metals. Cast red-brass (not yellow brass) or bronze-bodied fittings such as valves and couplings may be used when joining steel to copper, steel to stainless steel, or copper to stainless steel. Steel and stainless steel may connect directly to iron, but copper may not connect directly to iron.
- Q. Sleeve pipe passing through partitions, walls and floors:
 - 1. See Division 23 Section "Sleeves and Escutcheons for HVAC Piping."
 - 2. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
 - 3. Extend sleeves through floors as follows: In locations not otherwise indicated, 2 in. (50 mm) above finished floor level. In normally-dry locations such as finished office spaces under fintube and baseboard radiation, 1 in. (25 mm) above finished floor level. Finished floor level includes the thickness of floor finish materials such as carpet and tile. Caulk sleeves full depth and provide floor plate.
 - 4. Where piping passes through floor, ceiling or wall, close off space between pipe sleeve and construction with non-combustible insulation or with approved firestopping material when penetrating fire rated floors, ceilings or walls. Provide tight fitting metal escutcheons on both ends of sleeves to prevent movement of sleeve during piping expansion. Escutcheons shall be sized slightly larger than outside diameter of piping and smaller than diameter of sleeve. Escutcheons shall be rigidly secured to walls.
 - 5. Where piping passes through fire rated floors, ceilings or walls, close off space between pipe insulation and sleeve with approved firestopping material
 - 6. Install chrome-plated escutcheons where piping passes through finished surfaces.
- R. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Division 23 Section "HVAC Piping Insulation."
- S. In the erection of mains, use special care in the support, working into place without springing or forcing, and proper allowance made for expansion.
- T. Pipes shall be anchored, guided, and otherwise supported, where necessary, to prevent vibration or to control expansion.
- U. Make such offsets as are shown and required to place the pipes and risers in proper position to avoid other work.
- V. Take branch lines off bottom of mains or at 45 degree bottom angle, as space permits.

- W. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- X. Install a sufficient number of unions or flanged fittings to facilitate making possible future alterations or repairs.
- Y. Install concealed pipes close to building structure to keep furring to a minimum.
- Z. Provide access where valves and fittings are not exposed.
- AA. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- BB. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 09 Section "Painting."

3.3 CLEANING

- A. After satisfactory completion of pressure tests, before permanently connecting equipment, strainers, and the like, clean equipment thoroughly, blow and flush piping for a sufficient length of time as directed, so that interiors will be free of foreign matter. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.
- B. Fill, vent and circulate the system with approved solution in accordance with equipment (boiler, piping, coils, and others) manufacturer's recommendation, allowing it to reach design or operating temperatures. After circulating for 6 hours, drain the system completely and remove and clean strainer screens. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.
- C. Fill and vent system as required.
- D. Manually vent heat transfer units and high points of the system.
- E. Adjust the pressure reducing valve to provide minimum of 5 psig (35 kPa) pressure at the highest point of the system.
- F. After system has been completely filled, start zone pumps and circulate cold water for a short time to dislodge small air bubbles, and return them to air extraction device.
- G. Raise water temperature to 200 degrees F (93 degrees C) while operating pumps.
- H. Stop pump and vent radiation and high points of the system. Normal operation may now be started at any time.

3.4 TESTING

- A. No joint or section of piping shall be left untested.

- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, and other parts which are not designed to stand test pressures.
- C. Test piping for leaks under 100 psig (689 kPa) air pressure with soap suds prior to hydrostatic testing.
- D. Test piping hydrostatically to 1-1/2 times the maximum systems operating pressure, but in no case to less than 75 psig (517 kPa), for at least 4 consecutive hours, during which time pressure shall remain constant without pumping.
- E. Test and obtain Architect's approval before painting, covering, or concealing piping, including swing joints.

END OF SECTION 232113

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SECTION 232118 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Valves:
 - 1. Ball valves.
- B. Air vents.
- C. Strainers.

1.2 RELATED SECTIONS

- A. Division 23 Section “Hydronic Piping.”

1.3 REFERENCES

- A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- C. Submit inspection certificates for pressure vessels from authority having jurisdiction.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”
- B. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of glycol system for 1 year from date of substantial completion.
- B. Monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

PART 2 - PRODUCTS

2.1 VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Apollo.
 - 3. Crane.
 - 4. Hammond.
 - 5. Milwaukee.
 - 6. Victaulic Company.
 - 7. Watts.
 - 8. Wheatley.
 - 9. No substitutions.
- B. Globe or Angle Valves:
 - 1. Up To and Including 2 inch (50 mm):
 - a. Bronze body, bronze trim, screwed or union bonnet, rising stem and handwheel, inside screw, renewable composition disc and bronze seat, solder or threaded ends.
 - b. 150 lb S.W.P., 300 lb W.O.G.

- C. Ball Valves:
 - 1. Up To and Including 2 inch (50 mm):
 - a. Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle, solder or threaded ends.
 - b. 150 lb S.W.P., 600 lb W.O.G.
 - 2. Stem Extensions: Provide ball valves in insulated piping with stem extensions to allow for continuous thickness of field-installed insulation.

2.2 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.
 - 1.

2.3 STRAINERS

- A. Manufacturers:
 - 1. Sarco.
 - 2. Armstrong.
 - 3. Barnes and Jones.
 - 4. Bell & Gossett.
 - 5. Flo-Fab.
 - 6. Keckley Co.
 - 7. Muesco.
 - 8. Wheatley.
- B. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.

2.4 BALANCING VALVES AND COMBINATION BALANCING/SHUT-OFF VALVES.

- A. Manufacturers:
 - 1. Bell & Gossett.
 - 2. Armstrong.
 - 3. Flow Design, Inc.
 - 4. Gerand.
 - 5. Griswold Controls.
 - 6. Mepco.
 - 7. Nexus Valve.
 - 8. Taco.
 - 9. Tour and Andersson.
 - 10. Watts.
 - 11. Wheatley.
- B. Valves shall conform to one of the following:
 - 1. Fixed-Orifice Manual Balancing Valve: Calibrated, ball type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer with memory stop. Readout valves measure the pressure differential across the fixed orifice plate or venturi. Valve shall be designed for positive shut-off.
 - 2. Variable-Orifice Manual Balancing Valve: Cast iron or bronze, globe style, balance

valve with handwheel with vernier type ring setting and memory stop, readout valves equipped with integral check valves and gasketed caps. Readout valves measure the pressure differential across the variable opening between valve plug and valve seat. Valve shall be designed for positive shut-off. Drain valve may be furnished with this valve, and if positioned properly may be substituted for the separate drain valve indicated.

- C. Size balancing valves to allow a reading of 2 to 5 ft wg (6 to 15 kPa) pressure drop at design flow rates. Submittals shall include a chart of valve selections, indicating room number, terminal heating device tag, flow rate, pressure drop, and differential pressure reading.
- D. Insulation: Valves may be furnished with prefabricated thermal insulation. Flame spread reading shall be 25 or less per ASTM E84. R-value shall be 4 hr-sq.ft- F/Btu (0.704 K·m²/W) or greater. Install in accordance with Division 23 Section “HVAC Piping Insulation.”

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Valve Type Selection:
 - 1. Use, ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
 - 2. Use globe or ball for throttling, bypass, or manual flow control services.
 - 3. Use Bronze Globe Valves in throttling applications at control valve bypasses and in expansion tank connection.
 - 4. Use Bronze Ball Valves for general shut-off service in heating and cooling system piping 2 inch (50.8 mm) and smaller and at heating terminal units 2 inch (50.8 mm) and smaller, including fin-tube radiation, unit heaters, convectors and fan coil units.
 - 5. Use Combination Balancing, Flow Measuring and Tight Shut-off Valves at terminal heating and cooling units, zone branches and as indicated.
 - 6. Use Bronze Ball Valves for drain valves with hose connections. Provide valve of size indicated; if size isn't indicated, provide at least 3/4 inch (19 mm) valve size. Provide outlet fitting for standard “garden hose” with 3/4 inch (19 mm) hose threads. Provide brass cap with retainer chain. Compression-type “boiler drain valves” are not allowed.
- B. With the exception of valves which must be properly sized to ensure design flow rates (such as balancing valves), valves shall be line sized.
- C. For isolation valves, control valves and balancing valves located above suspended ceilings and in areas that are not visible to building occupants (for example, mechanical rooms), provide yellow colored surveyors tape. Permanently attach tape to valve handles and run tape down to 10 inches (254 mm) above ceiling or 12 inches (305 mm) below valve handle where ceilings do not exist (for example, mechanical rooms).
- D. Standard details for heating and cooling coils are based on single coil arrangements. For heating and cooling coils that are supplied in a split coil arrangement, with 2 or more individual coils, provide additional piping and balancing valves at each coil to ensure that flow through each coil is proportional to the percentage of total coil face area that the coil occupies.
- E. Install valves with stems upright or horizontal, not inverted.

- F. Install specialties in accordance with manufacturer's instructions.
- G. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- H. Provide manual air vents at system high points and as indicated.
- I. Provide balancing valves on water outlet from terminal heating and cooling units such as unit ventilators.
- J. Ensure that balancing valves are installed with minimum upstream length of straight pipe as recommended by the manufacturer.
- K. Ensure that balancing valves are installed with the readout valves fully accessible, including space required for insertion of metering probes.
- L. Standard details for heating and cooling coils are based on single coil arrangements. For heating and cooling coils that are supplied in a split coil arrangement, with two or more individual coils, provide additional piping and balancing valves at each coil to ensure that flow through each coil is proportional to the percentage of total coil face area that the coil occupies.

END OF SECTION 232118

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SECTION 233113 – HVAC DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal Ductwork.
- B. Kitchen Hood Ductwork.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Division 23 Section “Air Duct Accessories”: Kitchen hoods.
- B. Division 23: Sensors and airflow measuring stations furnished under Division 23 Section “Instrumentation and Control for Mechanical Systems”; gauges and meters.
- C. Division 26 – Electrical: Smoke detectors.

1.3 RELATED SECTIONS

- A. Division 23 Section “Testing, Adjusting and Balancing for HVAC.”
- B. Division 09 Section “Painting”: Weld priming, weather resistant, paint or coating.
- C. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”: Sleeves.
- D. Division 23 Section “Duct Insulation”: External insulation and duct liner.
- E. Division 23 Section “Air Duct Accessories”

1.4 REFERENCES

- A. ASTM
- B. AWS D9.1 - Welding of Sheet Metal.
- C. NBS PS 15 - Voluntary Product Standard for Custom Contact-Molded Reinforced-Polyester Chemical Resistant Process Equipment.
- D. NFPA
- E. SMACNA
- F. UL.

1.5 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes is permitted except by written permission from the Architect. Size proposed substitutions of round ducts in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.6 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures”.
- B. Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration. Submit prior to start of work.
- C. Product Data: Provide data for duct materials, duct liner and duct connectors.
- D. Samples:
 - 1. Submit as indicated on the Drawings, and as specified herein.
 - 2. Submit sample shop-fabricated mitered (vaned) and radiused elbows.
 - 3. Submit mock-up installation of a vertical fire damper.
- E. Test Reports: Submit testing apparatus, procedures, and preliminary forms prior to performing tests. On final reports, indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.
- B. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Indicate additional fittings used.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA HVACDCS.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.10 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures during and after installation of duct sealants.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flexible Ducts:
 - 1. Flexible Technologies Group - Thermaflex product line.
 - 2. Buckley Associates - Flexmaster Triple-Lock Buck Duct product line.
 - 3. No substitutions.

- B. Plastic Drawbands:
 - 1. Panduit.
 - 2. Thomas and Betts.
 - 3. Tyton.

- C. Tape for Flexible Ducts:
 - 1. Ideal Tape Co., division of American Biltrite Inc.
 - 2. 3M Company.
 - 3. Nashua Tape Products, division of Berry Plastics Corp.
 - 4. Venture Tape Corporation.
 - 5. No substitutions.

- D. Manufactured Ductwork - Round and Flat Oval:
 - 1. McGill AirFlow LLC, a subsidiary of United McGill Corporation.
 - 2. Aero Heating & Ventilating, Inc.; Portland, ME.
 - 3. Air Purchases, Inc.; Manchester, NH – spiral duct lengths.
 - 4. Atlantic Air Products LLC; Bow, NH.
 - 5. Hahnel Brothers; Bangor and Lewiston, ME.
 - 6. Hranec Corporation; Uniontown, PA.
 - 7. Lindab, Inc. – duct fittings only.
 - 8. Macy Industries, Inc.; Hookset, NH.
 - 9. Northeastern Sheet Metal Inc.; Goffstown, NH.
 - 10. Semco Inc., division of the Flakt Woods Group.
 - 11. S.G. Torrice Co.; Wilmington, MA – spiral duct lengths.
 - 12. Sheet Metal Connectors Inc.; Minneapolis, MN.
 - 13. Spiral Manufacturing Co. Inc.; Minneapolis, MN.
 - 14. Total Air Supply; Nashua, NH – spiral duct lengths.
 - 15. No substitutions.

- E. Manufactured Ductwork - Transverse Duct Connection System:
 - 1. Ductmate.
 - 2. HFC Enterprises; Baldwin Park, CA – Dura Flange product line, for round and flat oval ducts only.

- F. Manufactured Ductwork - Kitchen Hood Single-Wall Grease Duct:
 - 1. Ampco, a division of Hart & Cooley Inc.
 - 2. CaptiveAire.
 - 3. Grease Master.
 - 4. Metal-Fab Inc.
 - 5. Schebler Chimney Systems, a division of The Schebler Co.
 - 6. Selkirk.

- G. Manufactured Ductwork - Kitchen Hood Double-Wall Grease Duct:
 1. Ampco, a division of Hart & Cooley Inc.
 2. CaptiveAire.
 3. Metal-Fab Inc.
 4. Schebler Chimney Systems, a division of The Schebler Co.
 5. Selkirk.

- H. Sealants:
 1. Hardcast, a division of Carlisle Corporation.
 2. 3M Company.
 3. Ductmate.
 4. Foster.
 5. McGill AirSeal LLC, a subsidiary of United McGill Corporation.
 6. Mon-Eco Industries, Inc - Eco product line.
 7. Polymer Adhesive Sealant Systems.

2.2 MATERIALS

- A. Galvanized Steel Ducts:
 1. Steel sheet metal components of galvanized ductwork in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating (G90 minimum for outdoor or moist applications) conforming to ASTM A653 rating system and tested in accordance with ASTM A90.
 2. Provide paint-grip exterior surfaces for exposed ducts, where available.
 3. Sheet metal gauge shall be not less than 24 gauge (0.56 mm).

- B. Carbon Steel Ducts: ASTM A1008, A1011. Also known as black iron.

- C. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

- D. Stainless Steel Ducts: ASTM A167, Type 304 or 316. Material for exposed ducts shall have a finish at least equal to Mill Polished No. 4.

2.3 FLEXIBLE DUCTS

- A. Insulated Flexible Ducts:
 1. Semi-Rigid Flexible Aluminum Ductwork:
 - a. Flexmaster Triple-Lock Buck Duct - Insulated.
 - b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
 - c. Fiberglass insulation and fire-retardant polyethylene vapor retarder film.
 - d. Pressure Rating: Positive pressure 12 in. WG (2988 Pa) for all sizes. Negative pressure 12 in. WG (2988 Pa) for sizes thru 16 in. (406 mm) diameter, 8 in. WG (1993 Pa) for sizes 18 and 20 in. (457 and 508 mm) diameter.
 - e. Maximum Velocity: 5500 fpm (27.9 m/sec).
 - f. Inside bend radius: Minimum one diameter.
 - g. Temperature Range: -40 to 250 degrees F (-40 to 121 degrees C).
 - h. UL 181, Class 0 air duct.
 - i. Meets NFPA 90A and 90B standards.

2. Fabric-Core Flexible Ductwork:
 - a. Thermaflex Model M-KC.
 - b. Greenguard certified.
 - c. UL 181, Class 1, heavy fiberglass cloth fabric supported by helically wound spring steel wire; fiberglass insulation; reinforced metalized vapor barrier film.
 - d. Pressure Rating: 10 inches WG (2.5 kPa) positive and 2.0 inches WG (500 Pa) negative.
 - e. Maximum Velocity: 6000 fpm (30.4 m/sec).
 - f. Temperature Range: -20 to 250 degrees F (-28 to 121 degrees C).

B. Non-Insulated Flexible Ducts:

1. Semi-Rigid Flexible Aluminum Ductwork:
 - a. Flexmaster Triple-Lock Buck Duct - Bare.
 - b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
 - c. Pressure Rating: 12 inches WG (2988 Pa) positive for all sizes, 12 inches WG (2988 Pa) negative for sizes thru 16 in. diameter (406 mm), 8 inches WG (1992 Pa) negative for sizes 18 in. (457 mm) and 20 in. (508 mm) diameter.
 - d. Maximum Velocity: 5500 fpm (27.9 m/sec).
 - e. Inside bend radius: Minimum one diameter.
 - f. Temperature Range: -40 to 250 degrees F (-40 to 121 degrees C).
 - g. UL 181, Class 0 air duct.
 - h. Meets NFPA 90A and 90B standards.

- C. Return and Exhaust: Use either semi-rigid flexible aluminum type (insulated or bare), or fabric-core type (insulated). Non-insulated fabric-core type does not have adequate negative pressure rating.

2.4 ACCESSORIES

A. Drawbands for Flexible Ducts:

1. Stainless Steel: ½ inch (13 mm) wide with screw-driven worm gear.
2. Plastic: Panduit PLT5H or PLT8H; Thomas and Betts Dukt-Rap, VAL-26-50, or VAL-275X-25; or Tyton T150L or LX. Install with manufacturer's lever-action tightening tool.

- B. Tape for Flexible Ducts: Ideal-Seal 587A/B, UL 181B-FX listed, aluminum foil with pressure-sensitive acrylic adhesive, -20 to 250 degrees F (-28 to 121 degrees C) temperature range, 25.0 lb/in. width (109.4 N/25.4 mm width) tensile strength.

- C. Coating for Buried Ducts: Asphalt base.

- D. Concrete Ducts: ASTM C14; hub and spigot concrete sewer pipe with ASTM C443 joints, rubber gaskets.

- E. Fasteners: Rivets, bolts, or sheet metal screws.

- F. Sealants: See Duct Sealant portion of this Specification.

- G. Hanger Rod: ASTM A36; galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.5 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVACDCS, as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. SMACNA Duct Construction Manuals:
 - 1. The SMACNA recommendations shall be considered as mandatory requirements.
 - 2. Substitute the word "shall" for the word "should" in these manuals.
 - 3. Where the Contract Specifications differ from SMACNA recommendations, the more stringent requirements (as determined by the Architect) shall take precedence.
 - 4. Details on the Contract Drawings take precedence over SMACNA standards.
- C. Sheet metal shall be galvanized steel as specified in Part 2 paragraph "Materials" in this Section, unless otherwise indicated or specified.
- D. Construct Tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
 - 1. Where space is too restricted for full-radius elbows, provide mitered (square-throat) elbows with single wall turning vanes. Do not use air foil turning vanes.
 - 2. Mitered elbows in round or flat-oval ductwork shall be factory-manufactured.
 - 3. Radiused elbows with throat radius 1/2 times width of duct (centerline radius 1 width of duct) may be used instead of mitered elbows, but only where space is too restricted for full radius.
 - 4. Fittings not conforming to these requirements will be ordered removed and replaced with proper fittings.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence or convergence (per side) wherever possible; maximum 30 degrees divergence (per side) upstream of equipment and 45 degrees convergence (per side) downstream.
- F. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch (100 mm) cemented slip joint, brazed or electric welded. Prime coat welded joints.
- G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- H. Longitudinal locks or seams known as "button-punch-snap-lock" and other "snap-lock" types will not be permitted in rectangular duct. Snap-lock longitudinal seams may be used on round ducts up to 8 inches diameter, with screws provided to secure the seams at 24 inches (609 mm) on center maximum spacing.
- I. Exposed Ducts: Select and handle materials with care for a neat appearance. Joint connections on round and flat oval ducts shall be sleeve or flanged type; drawbands are not acceptable.

2.6 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufactured ductwork and fittings listed below are acceptable alternatives to standard ductwork systems. For exposed round and flat oval ductwork, factory-manufactured ductwork and fittings are required.

- B. Manufacture in accordance with SMACNA HVACDCS, and as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- C. Exposed Round and Flat Oval Ductwork: Shall be manufactured ductwork by one of the listed manufacturers.
 - 1. Spiral Ductwork Acceptable Products:
 - a. McGill Airflow: Standard Uni-Seal product line (smooth surface between spiral lockseams) or Uni-Rib product line (one standing seam reinforcement between each pair of spiral lockseams).
 - b. Other Manufacturers: Standard spiral product line (smooth surface between spiral lockseams).
 - c. Ductwork and fittings shall be products of a single manufacturer.
- D. Exposed Ducts:
 - 1. Select and handle materials with care for a neat appearance.
 - 2. Joint connections on round and flat oval ducts shall be sleeve or flanged type; drawbands are not acceptable. Joint connections on flat oval ducts 42 inches (1.07 m) and wider shall be flanged type to ensure tight fit and good appearance.
 - 3. Provide exterior reinforcing only where required, with prior approval from the Architect.
 - 4. External reinforcement of flat-oval ducts shall be full-perimeter angle rings. Straight angles along flat sides only are not allowed.
- E. Galvanized and stainless steel sheet metal used in fabrication shall be not less than 26 gauge (0.551 mm) thickness. Aluminum shall be not less than 0.025 in. (0.635 mm) nominal thickness. This requirement supersedes SMACNA requirements.
- F. Round and Flat Oval Duct and Fittings:
 - 1. Shall be suitable for at least 4 in. WG (996 Pa) positive pressure and 2 in. WG (498 Pa) negative pressure in accordance with SMACNA HVACDCS standards. This is a minimum; provide higher ratings where required.
 - 2. Fittings shall be fabricated of sheet metal at least one gauge heavier than straight duct of the same size.
 - 3. Fittings shall be factory-sealed so that no field sealing of joints between gores or segments is required. Acceptable methods of construction are fully welded, spot-welded with inner sealant, or standing-seam crimped joints.
- G. Radiused Elbows in Round and Flat Oval:
 - 1. In exposed ductwork shall be non-adjustable type, factory-sealed.
 - 2. In concealed ductwork may be adjustable type, with full long radius as detailed on the Drawings. Short-radius elbows are not allowed.
 - 3. Shall be constructed of the following minimum number of segments or gores: 90-degree: 4 gores; 60-degree: 3 gores; 45-degree: 3 gores; 30-degree: 2 gores; 22-1/2-degree: 2 gores.
 - 4. 1-piece stamped elbows are acceptable up to 12 inches (305 mm) diameter. Pleated elbows are acceptable up to 10 inches (254 mm) diameter.
- H. Mitered Elbows in Round and Flat Oval:
 - 1. Available in both 90-degree and 45-degree elbows.

2. Shall have minimum number of welded single-wall vanes as follows (size is duct width in plane of bend):
 - a. 3 to 9 inch (76 to 229 mm): 2.
 - b. 10 to 14 inch (254 to 356 mm): 3.
 - c. 15 to 19 inch (381 to 483 mm): 4.
 - d. 20 to 60 inch (508 to 1524 mm): 5.
 - e. Larger Sizes: 12-inch (305 mm) maximum spacing.

 - I. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.

 - J. Transverse Duct Connection System: SMACNA "F" rated or SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips. Product shall be Ductmate factory-manufactured connectors, or field-formed flanges using a specialized machine.
- 2.7 KITCHEN GREASE HOOD EXHAUST DUCTWORK
- A. Fabricate in accordance with SMACNA HVACDCS and NFPA 96.

 - B. Construct of 16 gauge (1.50 mm) carbon steel or 18 gauge (1.21 mm) type 304 or 316 stainless steel, using continuous external welded joints. Ductwork exposed to view or exposed to weather shall be stainless steel unless otherwise indicated.

 - C. Gaskets and sealants shall be rated for 1500 degrees F (815.6 degrees C) continuous operation.

 - D. Connection to Fan: Provide transition plate to fan base, of same material as duct. Outer perimeter shall be full size of fan base or curb. Inner opening shall be same size as duct and similar to fan inlet size. Inner opening shall be centered in plate to align with fan inlet and to maintain clearances. Duct shall be welded smoothly and continuously to the transition plate, preferably butt-welded to the underside of the plate or with plate corners turned down into duct, rather than duct turned out onto plate. Provide a smooth flat surface for installation of high-temperature gasket between transition plate and fan base. Fasten transition plate to the roof curb (or non-combustible wall opening).

 - E. Elbows:
 1. Mitered: Internal turning vanes are not allowed. Mitered elbows should be avoided in grease ducts except where indicated.
 2. Radiused: Provide full radius (centerline radius 1-1/2 times the duct width), continuously curved for rectangular duct, gored for round duct. In manufactured round duct, elbows may be manufacturer's standard, with throat radius as little as 6 inches (75 mm).

 - F. Factory-manufactured single-wall grease duct may be used where single-wall round duct is indicated.
 1. The system shall be UL Classified in accordance with UL 1978.
 2. The factory-built grease duct system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
 3. The system shall be designed to compensate for thermal expansion.
 4. The single wall exhaust shall be of type 430, 304 or 316 stainless steel. Minimum steel thickness shall be 0.035 inch (20 gauge) (0.89 mm).
 5. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.

6. The entire system from outlet to the termination, including accessories and support brackets, except as noted, shall be from the manufacturer. Access doors may be the product of other manufacturers.
 7. The diameter for the exhaust shall be verified by the manufacturers' computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
 8. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
 9. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.
- G. Factory-Manufactured Double-Wall Grease Duct with Zero Clearance to Combustibles:
1. Products:
 - a. Ampco - Model IVSI-4ZC.
 - b. Captive-Aire – Model DW-3Z (available diameters 8 to 24 in. (203 to 609 mm).
 - c. Metal-Fab - Models 3G and 4G.
 - d. Schebler - FyreGuard.
 - e. Selkirk - ZeroClear.
 2. The system shall be UL Classified in accordance with UL 1978 and UL 2221.
 3. The system shall be rated for zero clearance to combustibles.
 4. The outer shell shall have a 2 hour fire rating, as an integral enclosure eliminating field-built enclosures.
 5. The system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
 6. The system shall be designed to compensate for thermal expansion.
 7. The inner wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.035 inch (20 gauge) (0.89 mm)
 8. The outer wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.024 inch (24 gauge) (0.61 mm) on diameters up to 24 inches (609 mm), 0.035 inch (20 gauge) (0.89 mm) on diameters up to 36 inches (914 mm), and 0.048 inch (18 gauge) (1.21 mm) on larger sizes.
 9. The integral interstitial insulation shall be heavy-duty high-temperature blanket type. Thickness 3 or 4 inches (75 or 100 mm) as required for UL classification. The insulation shall be attached to the inner duct wall using metal bands and fasteners.
 10. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.
 11. Provide hood transitions, roof support section, and fan adapter.
 12. The entire system from outlet to the termination, including access doors, accessories and support brackets, except as noted, shall be from the manufacturer.
 13. The diameter for the exhaust shall be verified by the manufacturers' computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
 14. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
 15. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.
- H. Factory-Manufactured Double-Wall Grease Duct with ¾ inch (19 mm) Clearance to Combustibles:
1. Products:
 - a. Captive-Aire – Model DW-2R (available diameters 8 to 24 in. (203 to 609 mm).
 - b. Products of other manufacturers which are listed for zero clearance may be substituted. These products have thicker insulation and require additional space for installation, which is the Contractor's responsibility to provide.
 - 1) Ampco - Model IVSI-4ZC.
 - 2) Metal-Fab - Models 3G and 4G.

- 3) Schebler - FyreGuard.
- 4) Selkirk - ZeroClear.
- 2. The system shall be UL Classified in accordance with UL 1978 and UL 2221.
- 3. The system shall be rated for ¾ inch (19 mm) clearance to combustibles, measured from the duct outer shell.
- 4. The outer shell shall have a 2 hour fire rating, as an integral enclosure eliminating field-built enclosures.
- 5. The system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
- 6. The system shall be designed to compensate for thermal expansion.
- 7. The inner wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.035 inch (20 gauge) (0.89 mm)
- 8. The outer wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.024 inch (24 gauge) (0.61 mm) on diameters up to 24 inches (609 mm), 0.035 inch (20 gauge) (0.89 mm) on diameters up to 36 inches (914 mm), and 0.048 inch (18 gauge) (1.21 mm) on larger sizes.
- 9. The integral interstitial insulation shall be heavy-duty high-temperature blanket type. Thickness 2 or 3 inches (50 or 75 mm) as required for UL classification. The insulation shall be attached to the inner duct wall using metal bands and fasteners.
- 10. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.
- 11. Provide hood transitions, roof support section, and fan adapter.
- 12. The entire system from outlet to the termination, including access doors, accessories and support brackets, except as noted, shall be from the manufacturer.
- 13. The diameter for the exhaust shall be verified by the manufacturers' computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
- 14. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
- 15. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.

2.8 CLOTHES DRYER EXHAUST

- A. Fabricate in accordance with SMACNA HVACDCS.
- B. Construct of type 304 or 316 stainless steel, or aluminum.

2.9 PRESSURE CLASSIFICATION

- A. Ratings as indicated on the Drawings or as specified. See Ductwork Pressure Class Schedule in Part 3 of this Section.
- B. If no ratings are indicated, ductwork shall be rated for the external static pressure of the system plus 25 percent.
 - 1. If 4 dampers (of any type) or fewer can isolate a duct system, that portion of the system shall be rated for the shut-off pressure of the system fans.

2.10 DUCT SEALING

- A. Seal ductwork as outlined in the SMACNA HVACDCS. Seal ductwork to a minimum of class A (transverse joints, longitudinal seams, and duct wall penetrations), regardless of pressure class.

- B. Seal ductwork systems as required to ensure that maximum duct leakage does not exceed that allowed by the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual. Allow sealant to dry in accordance with manufacturer's requirements of time and environmental conditions before ductwork systems are pressurized.
- C. Duct sealing materials used shall be non-flammable and non-combustible in both liquid and solid states.
- D. Seal Pittsburgh hammered lockseams by flooding the joint with sealant prior to assembly.
- E. Seal exposed ducts by applying mastic-type or gasket-type sealer just before the joint or seam is made; remove excess sealant for a neat appearance.
- F. Fill (with matching duct material such as sheet metal) any gaps in duct which exceed the recommendations of the sealant manufacturer, and in no case shall liquid or mastic sealant be used to fill gaps or openings which exceed 1/8 inch (3.2 mm) in any direction. Verify that system air pressure acting on a wide gap will not exert enough force to damage or loosen the sealant.
- G. Materials for Sealing:
 1. Hardcast: Flex-Grip 550 or Iron-Grip 601 mastic.
 2. Hardcast: gypsum-based tape and mastic, waterproof type when used on moist-air exhaust or in humid or outdoor locations.
 3. Ductmate: Flanged lateral joints with gaskets.
 4. Ductmate: PROseal.
 5. Foster: Duct-Fas or Safetee mastic sealant. Duct-Fas is UV resistant and recommended for applications exposed to sunlight.
 6. Mon-Eco: Eco-Duct Seal 4450 (red color) or 4452 (grey color). Use grey color where ducts will be unpainted and exposed to public view.
 7. Polymer Adhesives Sealant Systems: Airseal No. 11 premium sealant.

2.11 UNIFORMITY OF MATERIALS

- A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors and airflow measuring stations furnished under Division 23 Section "Instrumentation and Control for Mechanical Systems"; gauges and meters; and smoke detectors furnished under Division 26 – Electrical.
- C. Install ducts in accordance with SMACNA HVACDCS.

- D. Duct Hangers and Supports:
1. Provide in accordance with SMACNA HVAC Duct Construction Standards, Section 4.
 2. Regardless of SMACNA standards, duct hangers shall be provided as follows:
 - a. Hang ducts up to and including 36 inches (914 mm) in width by a minimum of 1 in x 16 ga (25 mm x 1.61 mm) flat straps on each side of the duct on 4 ft (1.22 m) centers, bent under bottom of duct a minimum of 2 inches (50 mm) and securely fastened to duct. Hang ducts larger than 36 inches (914 mm) in width by 3/8 inch (9.5 mm) steel rods and 2 x 2 x 1/4-inch (50x50x6.3 mm) steel angle trapeze hangers, spaced 4 ft (1.22 m) on center. Anchor risers in the center of the vertical run to allow ends of riser free vertical movements.
 - b. Ducts with Extra Weight Such As Lead Lining or Lagging: Include the extra weight in determination of suitable hangers and supports.
- E. Hanging of Ductwork:
1. Attach supports only to structural framing members and non-metal deck concrete slabs.
 2. Support ductwork from the top chord of bar joists at the “Panel Points” or from the top flange of beams. Provide intermediate support consisting of steel angle or equal as required where supports are installed between joist spaces.
 3. Do not anchor supports to metal decking with or without a concreted slab.
- F. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- G. “Fishmouth” duct connections are not allowed.
- H. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.
- I. Exposed Ducts:
1. Handle with care for a neat appearance. Repair or replace dented or damaged ductwork as required by the Architect. Select hangers for appearance, and to prevent sagging or distortion of duct.
 2. Remove labels attached to ducts before receiving paint.
- J. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- K. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- L. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with crimp in direction of air flow.
- M. Use double nuts and lock washers on threaded rod supports. Strap hangers shall be minimum 16 gauge (1.50 mm) x 1 inch (25 mm) galvanized straps. Hanger and support components including but not limited to “unistrut” shall be galvanized steel except that where other duct materials are used, the hanger materials shall be compatible and non-corrosive to the duct. Wire hangers are not acceptable.

- N. Flexible Ducts:
1. Connect diffusers or light troffer boots to low pressure supply ducts directly or with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.
 2. Minimum bend radius shall be one and one half times the duct diameter. Support the bend to maintain this radius.
 3. Bends shall not exceed 45 degrees.
 4. Connect flexible ducts to metal ducts with 2 turns of duct tape and metal draw bands. Plastic drawbands may be used if they are installed using the band manufacturer's lever-action tightening tool. On insulated flexible ducts, provide an additional seal of tape and drawband on the insulation's vapor barrier.
- O. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.
- P. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Do not start ducted air moving equipment until construction is completed to a stage where airborne construction dust is no longer present. At the time of substantial completion, the entire air distribution system shall be turned over to the Owner clear of construction dust and debris. If the interior surfaces of any ducted air moving equipment or the interior surfaces of any portion of the ductwork distribution system are found, as determined by the Architect, to contain significant construction dust and debris, the entire air distribution system shall be cleaned in accordance with Division 23. If proper precautions are taken to prevent construction dust and debris from entering the ductwork during construction and if the Architect finds all ductwork to be free from such dust and debris, air duct cleaning shall not be required.
- Q. Install duct-mounted components furnished under other Sections of this Specification, such as smoke dampers, control dampers, control sensors, and smoke detectors. Install with straight lengths of duct as required for proper operation. Provide access at such components as required. Install in accessible locations for maintenance; notify the Architect if a location indicated or selected requires addition of access by other trades.
- R. Kitchen Grease Hood Exhaust Ductwork:
1. Install grease ducts without forming dips or traps.
 2. Use polished stainless steel for ductwork exposed to view, and stainless steel or carbon steel for ducts where concealed.
 3. Seams, joints, and penetrations shall have a liquidtight continuous external weld.
 4. Connect to hood as required by the Mechanical Code, NFPA 96, and manufacturer's instructions. If a factory raised angle collar is provided with the hood, provide a compatible angle on the duct end, and weld continuously or provide a bolted and gasketed connection to allow disassembly. If no factory collar is provided, insert the duct 1 inch into the hood and weld continuously. Do not field-modify or cut the hood with written permission from the Architect.
 5. At fan, provide a fan adapter of same construction as duct, with flat plate the full size of fan base or curb. Weld duct continuously to the plate, centered to maintain clearances to curb and straight inlet to fan. Provide a smooth flat surface for installation of fan gasket.
 6. Manufactured Ductwork: Install in accordance with manufacturer's instructions.
 7. Ducts shall not pass through fire walls or fire partitions.
 8. Clearances: Maintain minimum 18 inches (460 mm) from ductwork to combustible materials and minimum 3 inches (77 mm) from ductwork to limited combustible materials. Clearances may be reduced in accordance with manufacturer's UL listing for

- fire-resistive duct wrap, and for factory-manufactured double-wall ductwork.
9. Provide mechanical sealing adapter by Ansul Fire Protection (or equal by Kidde) to allow access by balancing contractor for balancing hood system. Coordinate size of mechanical sealing adapter with balancing contractor. Provide cap for adapter when not in use. Install mechanical sealing adapter in exhaust ductwork as close to exhaust fan as possible.

3.2 AIR DUCT LEAKAGE TESTS

- A. Perform air duct leakage tests in accordance with the testing procedures outlined in the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual.
- B. Leakage testing shall be performed on complete ductwork including fittings and accessories such as dampers, access doors, branch connections, and inlets and outlets. Flexible ducts, VAV boxes, air handling units, and duct coils may be excluded. Ducts may be temporarily sectioned and capped for testing, for reasons of limited test apparatus capacity, or requirements of construction phasing.
- C. Leakage tests, including retests as required, shall be performed prior to concealment and insulation and prior to building occupancy.
- D. The Following Duct Systems Shall Be Tested for Leakage, regardless of whether or not SMACNA recommends testing:
 1. Ductwork.
- E. Submit testing apparatus, procedures, and preliminary forms prior to performing tests.
- F. Once leakage tests are complete, submit leakage test report. Leakage test report forms shall include the following:
 1. Project and system identification data
 2. Description of ductwork under test
 3. Leakage class specified
 4. Test pressure specified
 5. Duct construction pressure class
 6. Duct design air flow
 7. Surface area of ductwork under test
 8. Maximum allowable leakage factor
 9. Calculated allowable leakage
 10. Test apparatus
 - a. Blower
 - b. Orifice, tube size
 - c. Orifice size
 - d. Orifice coefficient
 - e. Calibration date
 11. Test orifice differential pressure
 12. Leakage for tested section
 13. Total leakage for system
 14. Date of test
 15. Witnesses
- G. Air duct leakage testing shall be performed by an experienced agency that is independent of the

Testing, Adjusting and Balancing (TAB) Agency specified in Division 01 - Testing, Adjusting and Balancing.

- H. The TAB Agent shall witness the duct leakage tests performed under Division 23. At a minimum, the first duct leakage test shall be witnessed and approved by the TAB Agent and the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the TAB Agent. The TAB Agent shall confirm proper testing procedures and shall give written approval of the leakage tests. If deficiencies are discovered, the TAB agent shall document these deficiencies to the Contractor and the Engineer. Once deficiencies are corrected, the TAB Agent shall witness follow-up leakage tests.
- I. Coordinate with TAB Agency and receive written sign-off of the leakage tests by the TAB Agent prior to submitting leakage test report.
- J. Leakage Class Schedule:

DUCT PRESSURE CLASS	DUCT TYPE	LEAKAGE CLASS
Below 3 inch W.G.	Rectangular Metal	12
Below 3 inch W.G.	Round Metal	6
3 inch W.G. and above	Rectangular Metal	6
3 inch W.G. and above	Round Metal	3

3.3 SCHEDULES

A. Ductwork Material Schedule

AIR SYSTEM

MATERIAL

Low Pressure Supply
(Heating Systems)

Galvanized Steel, Aluminum

Low Pressure Supply
(System with Cooling Coils)

Galvanized Steel, Aluminum

Kitchen Grease Hood Exhaust

Steel, Stainless Steel

Clothes Dryer Exhaust

Aluminum, Stainless Steel

END OF SECTION 233113

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Dampers:
 - 1. Volume Control Dampers.
- B. Airflow Control Valves.
- C. Drip Pans.
- D. Duct Access Doors.
- E. Duct Sleeves, Prepared Openings and Closure Collars.
- F. Duct Test Holes.
- G. Flexible Duct Connections.
- H. Roof Curbs.
- I. Round Duct Branch Taps.
- J. Turning Vanes.
- K. Wire Mesh for Screens.
- L. General Exhaust Hoods.
- M. Kitchen Exhaust Hoods.
- N. Kitchen Hood Fire Extinguishing Systems.

1.2 RELATED SECTIONS

- A. Division 01.
- B. Division 07.
- C. Division 23 Section “Common Work Results for HVAC”
- D. Division 23 Section “Identification for HVAC Piping and Equipment.”
- E. Division 23 Section “HVAC Ducts.”
- F. Division 23: Pressure regulating damper assemblies.
- G. Division 26 “Electrical”: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ASTM C423-02a - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- B. ASTM E477-99 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- C. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. NFPA 92A - Smoke Control Systems.
- E. NFPA 70 - National Electrical Code.
- F. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
- G. SMACNA - HVAC Duct Construction Standards - Metal and Flexible, Third Edition - 2005 (HVACDCS).
- H. SMACNA - Seismic Restraint Manual - Guidelines for Mechanical Systems (SRMGMS).
- I. UL 33 - Heat Responsive Links for Fire-Protection Service.
- J. UL 94 - Safety of Flammability of Plastic Materials for Parts in Devices and Appliances Testing.
- K. UL 555 - Fire Dampers and Ceiling Dampers.
- L. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.
- M. UL 1995 - Heating and Cooling Systems.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section "Submittal Procedures."
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.
- C. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate for fire dampers and combination fire and smoke dampers.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Closeout Procedures."
- B. Record actual locations of access doors and test holes.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Protect dampers from damage to operating linkages and blades.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL

- A. Steel sheet metal components of accessories in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating conforming to ASTM A653 rating system and tested in accordance with ASTM A90. Provide paint-grip exterior surfaces for exposed ducts, where available.

2.2 DAMPERS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Air Balance, Inc.
 - 3. Arrow.
 - 4. Cesco.
 - 5. Greenheck.
 - 6. NCA.
 - 7. Tamco.
 - 8. Ventex.
 - 9. Vent Products, Inc.
 - 10. No substitutions.
- B. Volume Control Dampers:
 - 1. Factory-fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.
 - 2. Shop fabrication is permitted for single blade dampers only.
 - 3. Height is the dimension perpendicular to the blade rod or shaft. Width is the dimension parallel to the blade rod.
 - 4. Single Blade Dampers: For duct sizes (height x width) up to 7 x 30 inch (175 x 760 mm). When height or width exceeds its respective maximum, provide multi-blade damper.
 - 5. Multi-Blade Damper: Opposed blade pattern with maximum blade sizes (height x width) 8 x 72 inch (200 x 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

6. End Bearings: Except in round ductwork 6 inches (150 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings. Provide retainer clips or other devices to prevent bearings from pulling out. For single-blade dampers, plastic bearings are allowed.
 - a) Manufacturers:
 - 1) Duro Dyne.
 - 2) Elgen Manufacturing.
 - 3) Rossi.
 - 4) Ventfabrics.
 - b) Snap-in Plastic Bearings for Single-Blade Dampers: Designed to push into hole in sheet metal, with retaining tabs. Flame Retardant, Glass Reinforced, "Zytel" polymer by Dupont, conforming to UL 1995 and UL 94 with the required flammability rating of 5VA or lower. Acceptable materials include Polyamide 66 (PA66) (glass-reinforced Dupont Zytel), nylon and acetyl. Submit manufacturer's verification of the suitability of these bearings for the application, including operating pressures and temperatures.
7. Quadrants:
 - a) Manufacturers:
 - 1) Duro-Dyne.
 - 2) Elgen Manufacturing.
 - 3) Rossi
 - 4) Ventfabrics.
 - b) Duro-Dyne Specline SR and SRH series; Quadline series; or Stampline dial regulators and wedge-loc regulators. Or equal by Elgen, Rossi, or Ventfabrics. Factory-manufactured dampers shall have damper manufacturer's choice of quadrant equal to the Duro-Dyne products specified.
 - c) Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulators shall include lever handle, locking wing nut and graduated indicator dial. Provide shaft seals, bushings, or gaskets for duct penetrations. Quadrants without these features are not allowed.
 - 1) Rossi Everlock Regulators: Locking lever handle of Polyamide 66 (PA66) (glass-reinforced Dupont Zytel) plastic, thumb trigger with stainless steel spring, with at least 9 latching positions in a 90 degree rotation.
 - d) On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters, with open space to run insulation through.
 - e) Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends, with a single rod so that either regulator will control the entire damper.
8. Provide required operating wrenches for balancing, and furnish to the Owner at project completion.

2.3 IRIS DAMPERS

- A. Manufacturers:
 1. Ruskin - VFBD35 Series.
 2. Continental Fan Manufacturing Inc. – Iris Series.
 3. FanTech - IR Series.
- B. Galvanized steel construction, full circumferential neoprene or EPDM seals to inlet and outlet ducts, 6 CFM (10.2 m³/hr) maximum casing leakage, permanent plastic or metal pressure taps, accuracy +/-5 percent. Frame shall fully encapsulate iris blade segments, and have rolled edges for strength. Blade segments shall be internally linked to an adjustment knob or lever with

calibrated position indicator. Internal linkage fully encapsulated out of the airstream. Linear response of airflow to damper position. Designed for low self-noise generation.

- C. Blades open fully for duct cleaning. Full airtight closure capability is not required unless indicated on the Drawings.
- D. Installation Note: For precise metering of airflow, the iris damper should be located at minimum 1 diameter before or after an elbow, 3 diameters before a tee, 1 diameter after a tee, and 3 diameters before an outlet register.

2.4 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Standard Doors:
 - a) Ruskin.
 - b) Air Balance, Inc.
 - c) Arrow.
 - d) Buckley Associates.
 - e) Cesco.
 - f) DuctMate.
 - g) Greenheck.
 - h) Nailor.
 - i) Vent Products, Inc.
 - j) Shop fabricated.
 - 2. Medium and High-Pressure Doors:
 - a) Ruskin.
 - b) DuctMate.
 - c) Greenheck.
 - d) Nailor.
 - e) No substitutions.
 - 3. Grease Duct Doors:
 - a) Ductmate.
 - b) Shop fabricated.
- B. Fabricated in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings. Standard access doors and access doors for grease ducts may be shop-fabricated. Pressure rating shall be equal to the rating of the associated ductwork; see Part 3 Division 23 Section "HVAC Ducts" for schedule of pressure classes.
- C. Standard Doors: Removable, with retainer chain. Rigid and close-fitting with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1 inch (25 mm) thick insulation with galvanized steel sheet metal airstream-side cover.
 - 1. 16 inches (406 mm) Square and Smaller: Secure with two sash locks.
 - 2. Over 16 inches (406 mm), up to 24 inches (610 mm) Square: Provide four sash locks.
 - 3. Larger Sizes: Hinges and two compression latches with outside and inside handles.
 - 4. Clamping-type doors with knob handles, as manufactured by Ductmate, may be substituted for standard sizes.
 - 5. Material: Galvanized steel in galvanized steel ductwork. Stainless steel in stainless steel ductwork. Aluminum as manufactured by Arrow in aluminum ductwork.
 - 6. Provide in negative-pressure systems, and in positive-pressure systems with specified pressure class at or below 2 in. WG (498 Pa).

- D. Access Doors For Grease Duct Applications:
1. Shop-fabricated:
 - a) Material to match duct.
 - b) High-temperature ceramic gasket, suitable for at least 1500 degrees F (815.6 degrees C).
 2. Ductmate Industries, Inc. HI-TEMP access door, or approved equal.
 - a) 16 gage (1.61 mm) black iron backing plate.
 - b) High temperature ceramic gasket, 2300 degrees F (1260 degrees C) maximum.
 - c) Zinc plated conical springs, zinc coated wing nuts and zinc plated carriage bolts.
 3. Ductmate Industries, Inc. ULtimate or ULtimate II access door.
 - a) UL 1978 Listed.
 - b) UL label and "Do Not Obstruct" label.
 - c) 2 layers of 11 gage metal (provide black iron (carbon steel) or Type 304 stainless to match ductwork).
 - d) High temperature ceramic gasket, 2300 degrees F (1260 degrees C) maximum.
 - e) The ULtimate door is sandwich style, and requires no welding and special tools, but requires extra duct size.
 - f) The ULtimate II door has a welded frame, and is available with or without a piano hinge.
 - g) Collapsible loop handle welded to outer door.
 - h) Corner thumb bolts. ULtimate door has studs with wingnuts welded to inner door.
 - i) Can be used with high temperature insulation.
 4. For factory-manufactured round grease ducts, access doors may be furnished by the duct manufacturer. For double-wall ducts, access doors shall include inner and outer stainless steel and inner layer of insulation.
 5. Duct openings in horizontal ducts shall be above the bottom of duct to form a grease dam.
 6. Meet NFPA 96 requirements for use in grease duct systems.
- E. Access doors with sheet metal screw fasteners are not acceptable.
- F. Sizing: Select sizes to allow testing, service, and maintenance within the ductwork. Such access may require the insertion of one or both hands, arms, and shoulders as appropriate. Doors sized for viewing-only are not acceptable. Doors found to be of inadequate size shall be replaced with proper size.

2.5 DUCT SLEEVES, PREPARED OPENINGS AND CLOSURE COLLARS

- A. Duct Sleeves and Closure Collars: Fabricate from minimum 20 ga (1.0 mm) galvanized steel or equivalent thickness of aluminum, select material to match duct material. Where sleeves are installed in bearing walls, provide structural steel sleeves.
- B. Prepared Openings: Provide 1 inch (25.4 mm) clearance between the duct and the sleeve.

2.6 DUCT TEST HOLES

- A. Manufacturers:
1. Ductmate.
 2. Carlyle Corporation.
 3. Duro-Dyne.
 4. Ventfabrics.

- B. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- C. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.7 FLEXIBLE DUCT CONNECTIONS

- A. Manufacturers:
 - 1. Ductmate.
 - 2. Ventfabrics.
 - 3. Duro-Dyne.
 - 4. No substitutions.
- B. Fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.
- C. Connector: Fabric crimped into metal edging strip.
 - 1. Connectors shall be Ductmate PROFLEX Commercial series.
 - 2. Fabric: UL listed coated woven glass fiber fabric meeting the requirements of NFPA 90A and NFPA 701. Resistant to weather and most chemicals, fat, grease, and oil.
 - a) Supply Ducts: Neoprene coated, minimum density 30 oz per sq yd (1.0 kg/sq m). Fire-retardant coating. Black color. Temperature range -40 to 200 degrees F (-40 to 93 degrees C).
 - b) Exhaust Ducts Serving Fume Hoods: Hypalon coated, minimum density 24 oz per sq yd (0.8 kg/sq m). Flame proof coating. White color. UV and ozone resistant. Temperature range -40 to 250 degrees F (-40 to 121 degrees C).
 - 3. Net Fabric Width: Approximately 3 inches (75 mm) wide.
 - 4. Metal: 3 inch (75 mm) wide, 24 ga (0.6 mm thick).
 - a) Supply Ducts: G-60 galvanized steel.
 - b) Exhaust Ducts Serving Fume Hoods: Type 316 stainless steel.
 - 5. Connectors shall have double fold seams. Single fold seams (metal folded once only) shall not be accepted.

2.8 ROOF CURBS

- A. Manufacturers:
 - 1. Greenheck.
 - 2. Acme Engineering and Manufacturing Corp.
 - 3. Loren Cook.
 - 4. Thybar Corporation.
- B. For miscellaneous duct applications requiring roof curbs which are not specified with equipment in other Sections, provide curbs as specified in this Section.
- C. Construction: Galvanized steel or aluminum, with continuously welded seams, 1-1/2 in. (38 mm) thick rigid fiberglass insulation with 3.0 lb/cu.ft (48 kg/m³) density and coated for airstream exposure, base flashing flange at least 1-1/8 in. (38 mm) wide, and factory installed wood nailer strip installed with notched and lapped joints for strength. For curbs where duct is not continuous thru the curb (such as curbs with sound baffles), provide metal liner to keep the wood nailer out of the airstream. For curbs with hot ducts where clearance to combustibles is a

concern, wood nailer may be omitted.

- D. Height: For installations where base of curb is under the roof insulation, curb shall be 16 inch (400 mm) high (unless otherwise indicated or specified) with built-in cant strips. For installations where base of curb is not under any roof insulation (but may be under thin roof finish material such as membrane, shingles, or metal roofing), curb shall be at least 12 inch (300 mm) high (unless otherwise indicated) with no cant strips.
- E. Pitched Roof Curbs: Curbs for pitched and double-pitched roofs shall have base with built-in slopes to match roof pitches. Height of these curbs shall be at least the height specified above, measured at the highest point on the sloped base.
- F. Curb Seal: Provide rubber curb seal for installation between curb and equipment.

2.9 ROUND DUCT BRANCH TAPS AND SPIN-IN FITTINGS

- A. Saddle Taps: For round ducts branching off main ducts at 90 degrees, provide factory fabricated, saddle-tap fittings with conical or bellmouth taps, or 45 degree rectangular-to-round branch fittings. For round ducts branching off at 45 degrees, fittings do not require conical or bellmouth expansion. Fittings shall be furnished with flange for fastening and sealing designed to overlap onto adjacent duct, and shall be shaped to fit tight to the exterior of the duct, flat for rectangular duct, curved for round duct.
- B. Spin-in fittings, factory-fabricated with conical or bellmouth taps are an acceptable substitute for saddle taps.
- C. Factory-fabricated taps and spin-ins may be furnished with integral volume dampers and quadrants as specified in paragraph "Manual Dampers" in this Section.

2.10 TURNING VANES

- A. Manufacturers for Turning Vanes and Vane Rails:
 - 1. Ductmate Industries - PROrail 2 inch Turning Vane Rail.
 - 2. Duro Dyne - Junior Vane Rail.
 - 3. Hardcast, a division of Carlisle Corporation - Dyn-O-Rail Jr.
- B. Factory-fabricated and factory-or-field-assembled units consisting of curved turning vanes for uniform air distribution and change of direction with minimum turbulence and pressure loss. Provide curved single thickness vanes for mitered elbows with change in direction of 45 degrees or greater, conforming to SMACNA HVACDCS single vane schedule for small vanes. Each vane shall form a 90 degree arc. Fill the entire duct cross-section with vanes. Orient leading edge of vanes parallel to the side of the duct (directed straight into the entering airstream).
- C. Turning vanes shall be minimum 16 gauge (1.61 mm), regardless of gauges that are recommended by SMACNA. Double thickness turning vanes are not allowed.
- D. Turning vanes in rectangular ductwork and shop-fabricated round ductwork shall conform with details on the Drawings. If not detailed, the SMACNA detail for small-radius small-spacing single-thickness vanes shall be used.
- E. Turning vanes in manufactured round and flat oval duct elbows shall be the duct manufacturer's

standard size, spacing, and gauge, but must be single-wall and not less than 16 gauge (1.61 mm).

- F. Material for vanes shall be the same as the duct sheet metal.
- G. Factory-fabricated turning vane rails shall be a minimum of 24 ga (0.7 mm) and shall be the same material as the duct sheet metal.

2.11 WIRE MESH FOR SCREENS

- A. Manufacturers:
 - 1. McNichols Co.
 - 2. Banker Wire and Iron Works, Inc.
 - 3. Belleville Wire Cloth Co.
 - 4. Edward J. Darby & Son, Inc.
 - 5. No substitutions.
- B. Galvanized Welded Wire Mesh: Hardware and industrial class welded wire square mesh, hot dipped galvanized, welded trimmed construction, 2 mesh (2 openings per inch, wires ½ inch on center), 0.0630 inch wire nominal diameter parallel to width and length, 0.437 inch openings, 76 percent open area, 0.51 lb/sq. ft weight. Specification is the minimum acceptable for strength and weight of materials.
- C. Material to Match Ductwork: Where screens are installed in ductwork or louvers of other materials such as stainless steel or aluminum, provide screens of material to match the ductwork or louver, with strength equal to the requirements specified for galvanized mesh. Aluminum screens may be fabricated of expanded metal instead of welded wire.
- D. Provide mesh installed in a removable frame to support the mesh completely flat and rigid, with fasteners in an accessible location.

2.12 UNIFORMITY OF MATERIALS

- A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVACDCS. Refer to Division 23 Section "HVAC Ducts" for duct construction and pressure class.
- B. Install components furnished under other Section and Divisions of the Specifications. Such

items may include but are not limited to: Sensors and airflow measuring stations furnished under Division 23; gauges and meters; and smoke detectors furnished under Division 26 – Electrical.

- C. Duct Hangers and Supports: SMACNA HVACDCS, Section 4.
 - 1. Flexible Ducts: Support ducts by hangers every 3 feet (0.9 m), unless supported by ceiling construction. Stretch flexible air ducts to smooth out corrugations, and long radius elbows, where possible, using a minimum length to make connections.
 - 2. Flexible Connectors: Provide flexible connectors between fans and ducts or casings and where ducts are of dissimilar metals. For round ducts, securely fasten flexible connectors by zinc-coated steel clinch-type draw-bands. For rectangular ducts, lock flexible connectors to metal collars.

- D. Attach supports only to structural framing members and non-metal deck concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchors from puncturing the metal decking. Where supports are required between structural framing member, provide suitable intermediate metal framing. Where C clamps are used, use retainer clips.

- E. Access Doors:
 - 1. Provide duct access doors in horizontal return air, exhaust air and fresh air intake ductwork to facilitate the removal of accumulations of dust and combustible materials in accordance with NFPA 90A. Install access doors at maximum 20 foot (6 m) intervals and at the base of each vertical riser.
 - 2. Provide duct access doors for inspection, servicing, and cleaning before filters, before and after coils, before and after fans, before automatic dampers, at fire dampers, at smoke dampers, at combination fire and smoke dampers, at smoke detector sampling tubes (upstream of the sampling tube), at multiple blade volume dampers, at backdraft and counterbalanced dampers, and elsewhere as specified or as indicated on the Drawings. Provide at changes in direction of kitchen exhaust ductwork and as otherwise required for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as specified or as indicated on the Drawings. Review locations prior to fabrication.
 - 3. Access doors installed for access to fire dampers and fire/smoke dampers shall have one side at least 12 inches long to allow two hand access. Provide identification with letters of minimum 1/2 inch (13 mm) height to indicate the presence of fire protection devices within. Conform with NFPA 90A and applicable Codes. Refer to Division 23 Section “Identification for HVAC Piping and Equipment” for labeling materials specifications.

- F. Grease Duct Access Doors:
 - 1. Provide approved access doors at the following locations:
 - a) Changes in direction of kitchen exhaust ductwork.
 - b) Every 12 feet for non-vertical ductwork.
 - c) Where duct pass through multiple floors, provide access door at each floor.
 - 2. Provide nameplate of suitable material on access doors stating “ACCESS PANEL - DO NOT OBSTRUCT”. Install access doors on top or sides of duct; in horizontal ducts, locate opening above the bottom of the duct to prevent formation of a grease dam.

- G. Provide fire dampers , combination fire and smoke dampers and smoke dampers where ducts and outlets pass through fire rated components. Install with required perimeter mounting

angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

- H. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
- I. Fire Damper Testing: Demonstrate operation and re-setting of each fire damper and fire/smoke damper to Owner's representative after installation and prior to building occupancy. Remove or melt the fusible link and allow the damper to close, then reopen the damper and replace the link. Repair or replace any damper which doesn't close and open properly. Coordinate with access door installation to ensure that access doors are of adequate size and location to allow required reach with 2 hands to hold the damper open while replacing the link.
- J. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- K. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- L. Provide balancing dampers on high velocity systems where indicated. Refer to Division 23.
- M. Provide balancing dampers on duct take-offs to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly. Where branch duct is completely above non-accessible wallboard ceiling and the Architect has not approved the use of access doors, duct mounted balancing dampers shall not be required.
- N. For volume dampers located above suspended ceilings and in areas that are not visible to building occupants (e.g. mechanical rooms), provide fluorescent orange colored surveyor's tape. Permanently attach tape to damper handles and run tape down to 10 in. (254 mm) above ceiling or 12 in. (304 mm) below damper handle where ceilings do not exist (e.g. mechanical rooms).
- O. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and support by vibration isolators. Staple and seal connections airtight.
- P. Duct Sleeves and Prepared Openings: Install for ducts passing through roofs, ceilings, walls and floors. Field determine the proper size and location of sleeves and prepared openings.
 - 1. Duct Sleeves: Allow one-inch (25 mm) clearance between duct and sleeve or one-inch (25 mm) clearance between insulation and sleeve for insulated ducts, except at grilles, registers, and diffusers.
 - 2. Prepared Openings: Allow one-inch (25 mm) clearance between duct and opening or one-inch (25 mm) clearance between insulation and opening for insulated ducts, except at grilles, registers, and diffusers.
- Q. Closure Collars:
 - 1. Provide not less than 4 inches (100 mm) wide on each side of walls or floors where sleeves or prepared openings are installed. Fit collars snugly around ducts. Grind smooth edges of collar to prevent tearing or puncturing insulation covering or vapor barrier.
 - 2. Where insulated ducts penetrate non-fire-rated walls, insulation shall be continuous through the closure collars and the closure collars shall be installed tight to the insulation.

3. Where insulated ducts penetrate fire rated walls, insulate ducts on both sides of closure collars and seal points of contact between closure collar and insulation with vapor proof adhesive.
 4. Where ducts penetrate fire rated walls, provide fire proof sealant at closure collar. Refer to Division 07 for fire proof sealant requirements.
 5. Secure closure collars to ducts with sheet metal screws at maximum 6 inch (152 mm) centers and secure closure collars to walls or floors with sheetrock screws, nails or other appropriate fastener at maximum 6 inch (152 mm) centers.
 6. Packing: Pack with non-combustible glass fiber insulation in spaces between sleeve/opening and duct/duct insulation. Cover or seal edges of packing to contain loose fibers.
- R. Provide duct test holes where indicated and required for testing and balancing purposes.
- S. Provide interconnecting power and control wiring as required, in accordance with Division 26.

END OF SECTION 233300

SECTION 233813 - COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes Type I commercial kitchen hoods.

1.3 DEFINITIONS

- A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.
- B. Standard Hood: A hood, usually field fabricated, that complies with design, construction, and performance criteria of applicable national and local codes.
- C. Type I Hood: A hood designed for grease exhaust applications.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Standard hoods.
 - 2. Filters/baffles.
 - 3. Fire-suppression systems.
 - 4. Lighting fixtures.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
 - 2. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
 - 3. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
 - 4. Show drain piping connections.
 - 5. Show control cabinets.
 - 6. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
 - 7. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 8. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 9. Wiring Diagrams: Power, signal, and control wiring.
 - 10. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in

requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

- C. Welding certificates.
- D. Manufacturer Seismic Qualification Certification: Submit certification that commercial kitchen hoods, accessories, and components will withstand seismic forces defined in Division 23. Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.
- C. 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.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 COORDINATION

- A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

1.7 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. Furnish one complete set(s) of grease filters/baffles.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL KITCHEN HOODS

- A. Approved Manufacturers:

1. Captive Aire
2. Halton.
3. Greenheck
4. Greasemaster

B. Hood:

1. Furnish and install a complete kitchen exhaust canopy. The canopy shall bear the Underwriters' Laboratories U.L. label. U.L. listed range hood without exhaust fire damper per Standard 710 and be fabricated in compliance with NFPA96, and shall bear the National Sanitation Foundation Seal of Approval (NSF).
2. The installation shall be in accordance with the manufacturer's recommendations and conform to NFPA96 Guidelines and all applicable local codes.
3. Size shall be as indicated on Drawing and or Specifications.
4. All necessary angle and channel supports shall be included.
5. Hood systems shall be balanced by TAB contractor prior to substantial completion.
6. Each hood shall be furnished and installed with a controls and ANSUL Fire Extinguishing System cabinet. The cabinet shall be located in one (1) end of hood. The cabinet shall be capable of housing the ANSUL Automan, magnetic starters, and relays, etc.
7. The canopy inner liner shall be 18-gauge stainless steel, where exposed, Type 304 with #4 finish. The canopy shall have integral exhaust duct collars. All seams of the inner liner shall have grease tight joints. Each canopy shall have a filter housing of the same material as the canopy liner. The filter housing shall be equipped with a pitched drip tray the full length of the canopy and with grease cup for easy removal and daily cleaning.
8. The outer shell shall be 18-gauge stainless steel, where exposed, Type 304 with #4 finish. Canopy ends shall be double side wall construction. All exterior joints shall be continuously welded liquid-tight and ground smooth and be polished to #4 finish.
9. Canopy shall have U. L. listed vaporproof lights suitable for grease use on 3 - 4 foot center prewired to a junction box on top of the canopy.
10. The exhaust air flow rates will be based on the convective heat generated by appliances underneath each canopy. Submitted hood designs shall include convective heat calculations based on the input power of the appliance serviced.
11. The hood manufacturer will supply a master electric panel (MEP) consisting of one starter per motor, main disconnect switch, terminal block wiring and control circuits prewired. The MEP shall be contained within the controls and fire extinguishing cabinet.
12. Enclosure Panels: Where required, the hood manufacturer shall provide panels constructed of the same steel as the exposed hood surfaces. A mounting clip is factory welded to the top of the hood to accommodate field installation of enclosure panels exceeding 6" high. Panels shall be sized to extend from the top of the hood to the drop ceiling.
13. Hoods shall extend a minimum of 6 inches beyond the sides of the equipment and 12 inches over front of the equipment. Refer to detail for mounting height AFF.
14. Provide UL listed, factory-installed motorized damper at the hood collar.

C. Exhaust Fan:

1. Furnish and install where indicated on drawings, separate roof exhaust fans with capacities and sizes as scheduled. Fans shall be complete, including the following:
 - a. The exhaust fans shall be supplied by the hood manufacturer. The fans shall be the belt drive, upblast type. Base shall be epoxy-coated steel construction. Fan housings shall be heavy-duty spun aluminum. The motor compartments shall be isolated and forced cooled by air drawn from outside the fans through breather

tubes. The fans shall be U. L. rated under #762 for grease laden vapors. The motors shall be continuous duty type with shielded ball bearings. The drives shall be the variable speed V belt type.

- b. Fan ratings shall be AMCA certified.
- c. Provide integral grease through at base of housing.
- d. The fans shall have hinged subbases with flexible weatherproof electrical cables and service hold-open retainers to permit proper inspection and cleaning.
- e. Provide factory-fabricated roof curbs with proper height (but in no case less than 18" high) to insure that the fans discharge a minimum of 40" above the roof surface.
 - 1) Curbs shall be constructed of galvanized steel and shall incorporate a non-combustible gasket around perimeter top and be designed for installation on flat roof.
 - 2) Curbs shall be installed, shimmed for roof pitch, leveled and flashed by Roofing Contractor.
- f. Provide disconnect switch equal to Bryant Electric model 30102.
 - 1) Silver-alloy contacts.
 - 2) Brass binding screw terminals with combination Robertson / Phillips / slothead.
 - 3) Back wiring: clamp-type terminals accept up to #10 wire.
 - 4) Non-tracking urea base.
 - 5) Nylon toggle.
 - 6) Fully enclosed.
 - 7) Quick make, slow break contact design.

2.2 KITCHEN EXHAUST HOOD FIRE EXTINGUISHING SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ansul
 - 2. Kidde
- B. Hood Fire Extinguishing System:
 - 1. The hood shall contain an Ansul R-102 or a wet chemical fire suppression system. The system shall be properly sized for the duct, plenum and appliances. The system shall be completely installed by factory trained personnel. Field hook-up shall be subcontracted to an authorized factory representative and shall be performed after hood installation. System activation shall be by fusible link connected to automatic release or manual pull station.
 - 2. The installation shall be in accordance with UL listing and conform to local and state codes and standards, including NFPA 17A and U. L. Standard 300, November 1994.
 - 3. Materials:
 - a. Cylinders shall be manufactured, tested and marked in accordance with DOT Specifications. Charge with "Karbalyo II" or approved equal extinguishing and pressurize with nitrogen. Provide suitable brackets for mounting.
 - b. Piping shall be Schedule 40, black steel with malleable iron fittings. Discharge nozzles shall be of the proper design for the intended use (duct nozzle, plenum nozzle, appliance nozzle) and orifices shall be protected with appropriate seals.
 - 4. Controls for automatic operation and manual release shall be mechanical in design, using fusible metallic links, stainless steel cabling, corner pulleys and manual pull-station. Provide a pressure release device for automatic opening of the cylinder valves.

5. Provide relays to shut down hood fan and actuate the building fire alarm system. Relays for interface with fire alarm system shall be suitable for use in supervised systems. Coordinate with Electrical Contractor for shutting down of electrical power sources under hoods and closure of main gas valve through Emergency Shut Down Panel. Wiring to this equipment through these devices is included in the Electric Section of these Specifications. The Owner shall be instructed in the operation and maintenance of the system.
6. Perform tests and submit certificates of approval as required by local officials. Also submit manufacturer's report certifying final inspection and system test.
7. Pull device shall be located next to exit from space. Pull device shall be fully recessed in wall and conduit shall be concealed.
8. A start-up test shall be required. Copies of the test shall be submitted for approval.

2.3 MAKE-UP AIR UNIT

- A. Approved Manufacturers (manufacturer shall match hood manufacturer):
 1. Captive Aire
 2. Halton.
 3. Greenheck
 4. Greasemaster
- B. Description: A modular packaged heating, cooling and ventilating unit(s), as indicated on the drawings shall be furnished. Unit(s) shall be tested in accordance with ANSI Standard Z83 and shall bear the ETL label. Orientation shall be horizontal, down or side discharge. Unit(s) shall be factory assembled, tested and shipped as a complete packaged assembly, for outdoor mounting, consisting of the following:
 1. Gas burner
 2. Centrifugal blower (forward-curved double width/double inlet or backward inclined)
 3. Motor starter with thermal overload protection
 4. Motor and drive assembly
 5. Fuel burning and safety equipment
 6. Temperature control system
 7. Gas piping
 8. Pre-piped and charged condenser(s)
- C. Construction
 1. Housing: Unit housing shall be constructed of 20 gauge G-90 galvanized steel. The wall panels and roof panels shall be fabricated by forming double-standing, self-locking seams that require no additional support. The floor and wall panels shall be caulked air tight with a silicone caulk. All casing panels shall be attached with sheet metal screws or rivets, which can be removed to field service large components. The unit base shall be suitable for curb or flat mount. Housing construction should be suitable for outdoor installation.
 2. An observation port shall be located on the exterior of the unit for observation of the main flame and pilot flame. All controls, gas valves, modulating controls and electrical components shall be mounted within the burner vestibule. The burner vestibule shall be an integral part of the unit and not extend outside the exterior casing of the unit and not exposed to the main air stream. The vestibule full-size door shall provide easy access to controls and gas-train components. Blower door shall provide easy access to blower,

- motor and drives. Access doors shall be provided on both front and backside of unit providing full access to every part of the unit.
3. Internal ridged board 1" x 1.5" foil face installation shall be installed on roof, walls and base of casing.
- D. Base: The base shall be constructed of galvanized steel for improved rigidity. Base shall be structurally reinforced to accommodate the blower assembly and burner.
- E. Blower:
1. Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with setscrews and keys. The blower assembly shall be isolated from the fan structure with vibration isolators.
 2. External Static is the sum of duct loss plus duct component static pressure. All blowers shall be tested and set at rated speed after being installed in the factory-assembled unit.
 3. Direct Drive
 - a. Direct drive blower assembly shall consist of a centrifugal backward inclined, non-overloading wheel secured directly to a heavy duty, ball bearing type motor via two set screws.
 - b. The motor and wheel assembly shall be mounted to a heavy gauge galvanized steel frame.
 - c. The motor shall be controlled by a variable frequency drive, allowing for variable airflow without the need of belts and pulleys.
- F. Motor & Motor Compartment: Motors shall be heavy-duty ball bearing type and furnished at the specified voltage, phase and enclosure. Motor mounting plate shall be constructed of heavy gauge galvanized steel and shall be designed to provide easy adjustment of the belt tension.
- G. Shaft & Bearings: Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested, specifically for use in air handling applications.
- H. Burner
1. The gas burner shall be direct-fired, draw-through type.
 2. The burner shall burn over its entire length at all times when the system is in operation.
 3. The burner shall have non-clogging, 4302B stainless-steel combustion baffles attached to a ductile aluminum gas-supply section with no moving parts to wear out or fail. The burner shall be capable of 92% combustion efficiency with a maximum turndown ratio of up to 30 to 1.
 4. The gas burner shall be furnished with a pilot package arranged so that the pilot flame lights the burner with instantaneous ignition. Pilot assembly includes a flame rod, spark rod and pilot, which is automatically ignited by ignition transformer. A flame-rod rectification system shall be used to prove pilot and main flame.
 5. Rear access doors will provide complete access to burner and pilot assembly.
 6. Burner profile plates shall be self-adjusting to operate across the complete CFM range of each model heater. Every unit shall be designed for variable air volume capabilities.
- I. Cooling Coil Section

1. Cooling coil section shall be field bolted directly to discharge of blower section. Coil section to be designed to fit onto common curb with main unit. Base of coil section to be constructed with double pitch stainless steel drain pan for coil, same as main unit. Casing and roof to be 20-gauge G-90 galvanized construction. Inside of section to be fully insulated with foil back insulation. DX coil to meet scheduled requirements.
2. Cooling interlock relay. Locks out burner circuit when cooling is energized.
3. Single circuit modular packaged DX cooling option for packaged unit. Includes condenser, DX coil, filter/dryer kit, thermal expansion valve, R-410A refrigerant, and refrigerant piping.
4. DX cooling intake air thermostat and relays mounted in unit - set point for thermostat should be 85°F.
5. Moisture eliminator - allows cooling coil face velocity to increase to 650 FPM.

J. Accessories

1. Dampers: Manufacturer shall provide and install on unit, a two-position, motor-operated damper with internal end switch to energize the blower-starter circuit, when damper is 80% open. Blades shall be a maximum of 6" wide 16-gauge G-90 galvanized steel and shall be made to guarantee the absence of noticeable vibration at design air velocities. Damper blades are to be mounted on friction-free synthetic bearings. Damper edges shall have PVC coated polyester fabric mechanically locked into blade edge. Jamb seals used are flexible metal, compression type.
2. Filters: The filters shall be (2") thick, pleated throw away. Filter media is supported on the air leaving side by a metal grid.
3. Filter Section: Shall be insulated constructed of G-90 galvanized steel with filters supported by internal slides and with removable access panels.
4. Fresh-Air Inlet Hood/Filter Combination: Shall be constructed of G-90 galvanized steel with bird screen and (2") cleanable filters supported by internal slides mounted in the inlet face of the hood.
5. Curb: 20" curb shall be constructed of 18-gauge aluminized steel as a completed welded assembly.

K. Temperature control systems

1. Discharge Temperature Control: Use for building exhaust-air replacement to maintain a constant discharge temperature of supply air. The burner flame modulates and the cooling compressors cycle to compensate for outdoor temperatures. Discharge air temperature setpoint shall be reset between 65 deg F (heating setpoint) and 80 deg F (cooling setpoint).

L. Wiring and electrical

1. Each condenser shall have a separate circuit enabling the supply fan motor to accept signals from a VFD without interfering with condenser operation.
2. Unit(s) shall be complete with all items such as relays, starters, switches, safety controls, conduit and wire, and as required for proper operation. All factory-mounted controls shall be factory pre-wired to the unit control panel. A safety disconnect switch shall be standard on all units and shall be sized according to the unit.

M. Factory tested

1. Unit(s) shall be operated, tested and set at the factory using job-site conditions for electrical and gas input. All operating and safety controls shall be tested and set at the factory. Adjustable or fixed sheaves shall be set for proper RPM at specified conditions. Gas-pressure regulator shall be set for specified burning rate at specified inlet pressure.

- N. Service and parts
 - 1. The supplier shall furnish as built wiring connection and control-circuit diagrams, dimension sheets and a full description of the unit(s). Service manuals, showing service and maintenance requirements, shall be provided with each unit.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, 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 equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Complete field assembly of hoods where required.
 - 1. Make closed butt and contact joints that do not require filler.
 - 2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication Requirements" Article.
- B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.
- C. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.
- D. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.
- E. Install hoods to operate free from vibration.
- F. Install closure panels above hood to extend above ceiling as required.
- G. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches (1200 mm) o.c. maximum.
- H. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.
- I. Install lamps, with maximum recommended wattage, in equipment with integral lighting.
- J. Set initial temperatures, and calibrate sensors.
- K. Set field-adjustable switches.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping with clearance to allow service and maintenance.
- C. Connect ducts according to requirements in Division 23 Section "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquidtight joint.
- D. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.4 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.
 - 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. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
 - 4. Perform hood performance tests required by authorities having jurisdiction.
 - 5. Perform fire-suppression system performance tests required by authorities having jurisdiction.
- D. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods. Refer to Division 01.

END OF SECTION 233813

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SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Supplemental requirements applicable to Work specified in Division 26 and Division 28.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8PSJ or 8P8C: Miniature 8-position series jack, also called an 8-position 8-contact modular jack for some applications.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AIC: Ampere interrupting capacity.
6. AL, Al, or ALUM: Aluminum.
7. ASD: Adjustable-speed drive.
8. ATS: Automatic transfer switch.
9. AWG: American wire gauge; see ASTM B258.
10. BAS: Building automation system.
11. BIL: Basic impulse insulation level.
12. BIM: Building information modeling.
13. CAD: Computer-aided design or drafting.
14. CATV: Community antenna television.
15. CB: Circuit breaker.
16. CO/ALR: Copper-aluminum, revised.
17. COPS: Critical operations power system.
18. CU or Cu: Copper.
19. CU-AL or AL-CU: Copper-aluminum.
20. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
21. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
22. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
23. dBm: Decibel absolute power with respect to 1 mW.
24. DC or dc: Direct current.
25. DCOA: Designated critical operations area.
26. DDC: Direct digital control (HVAC).
27. EGC: Equipment grounding conductor.
28. EMF: Electromotive force.
29. EMI: Electromagnetic interference.
30. EPM: Electrical preventive maintenance.
31. EPS: Emergency power supply.

32. EPSS: Emergency power supply system.
33. ESS: Energy storage system.
34. EV: Electric vehicle.
35. EVPE: Electric vehicle power export equipment.
36. EVSE: Electric vehicle supply equipment.
37. fc: Footcandle, a unit of illuminance equal to one lumen per square foot.
38. FLC: Full-load current.
39. ft: Foot.
40. GEC: Grounding electrode conductor.
41. GFCI: Ground-fault circuit interrupter.
42. GFPE: Ground-fault protection of equipment.
43. GND: Ground.
44. HACR: Heating, air conditioning, and refrigeration.
45. HDPE: High-density polyethylene.
46. HID: High-intensity discharge.
47. HP or hp: Horsepower.
48. HVAC: Heating, ventilating, and air conditioning.
49. Hz: Hertz.
50. IBT: Intersystem bonding termination.
51. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
52. IP: Ingress protection rating (enclosures); Internet protocol (communications).
53. IR: Infrared.
54. IS: Intrinsically safe.
55. IT&R: Inspecting, testing, and repair.
56. ITE: Information technology equipment.
57. kAIC: Kiloampere interrupting capacity.
58. kcmil or MCM: One thousand circular mils.
59. kV: Kilovolt.
60. kVA: Kilovolt-ampere.
61. kVA_r or kVAR: Kilovolt-ampere reactive.
62. kW: Kilowatt.
63. kWh: Kilowatt-hour.
64. LAN: Local area network.
65. lb: Pound (weight).
66. LCD: Liquid-crystal display.
67. LCDI: Leakage-current detector-interrupter.
68. LED: Light-emitting diode.
69. LNG: Liquefied natural gas.
70. LP-Gas: Liquefied petroleum gas.
71. LRC: Locked-rotor current.
72. MCC: Motor-control center.
73. MDC: Modular data center.
74. MG set: Motor-generator set.
75. MIDI: Musical instrument digital interface.
76. MLO: Main lugs only.
77. MVA: Megavolt-ampere.
78. mW: Milliwatt.
79. MW: Megawatt.
80. MWh: Megawatt-hour.
81. NC: Normally closed.
82. NiCd: Nickel cadmium.

83. NIU: Network interface unit.
84. NO: Normally open.
85. NPT: National (American) standard pipe taper.
86. OCPD: Overcurrent protective device.
87. ONT: Optical network terminal.
88. PC: Personal computer.
89. PCS: Power conversion system.
90. PCU: Power-conditioning unit.
91. PF or pf: Power factor.
92. PHEV: Plug-in hybrid electric vehicle.
93. PLC: Programmable logic controller.
94. PLFA: Power-limited fire alarm.
95. PoE: Power over Ethernet.
96. PV: Photovoltaic.
97. PVC: Polyvinyl chloride.
98. pW: Picowatt.
99. RFI: Radio-frequency interference (electrical); Request for interpretation (contract).
100. RMS or rms: Root-mean-square.
101. RPM or rpm: Revolutions per minute.
102. SCADA: Supervisory control and data acquisition.
103. SCR: Silicon-controlled rectifier.
104. SPD: Surge protective device.
105. sq.: Square.
106. SWD: Switching duty.
107. TCP/IP: Transmission control protocol/Internet protocol.
108. TEFC: Totally enclosed fan-cooled.
109. TR: Tamper resistant.
110. TVSS: Transient voltage surge suppressor.
111. UL: Underwriters Laboratories, Inc. (standards) or UL LLC (services).
112. UL CCN: UL Category Control Number.
113. UPS: Uninterruptible power supply.
114. USB: Universal serial bus.
115. UV: Ultraviolet.
116. V: Volt, unit of electromotive force.
117. V(ac): Volt, alternating current.
118. V(dc): Volt, direct current.
119. VA: Volt-ampere, unit of complex electrical power.
120. VAR: Volt-ampere reactive, unit of reactive electrical power.
121. VFC: Variable-frequency controller.
122. VOM: Volt-ohm-multimeter.
123. VPN: Virtual private network.
124. VRLA: Valve-regulated lead acid.
125. W: Watt, unit of real electrical power.
126. Wh: Watt-hour, unit of electrical energy usage.
127. WPT: Wireless power transfer.
128. WPTE: Wireless power transfer equipment.
129. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.

3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit.
7. EPEC-40: Schedule 40 electrical HDPE underground conduit.
8. EPEC-80: Schedule 80 electrical HDPE underground conduit.
9. EPEC-A: Type A electrical HDPE underground conduit.
10. EPEC-B: Type B electrical HDPE underground conduit.
11. ERMC: Electrical rigid metal conduit.
12. ERMC-A: Aluminum electrical rigid metal conduit.
13. ERMC-S: Steel electrical rigid metal conduit.
14. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
15. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
16. ERMC-SS: Stainless steel electrical rigid metal conduit.
17. FMC: Flexible metal conduit.
18. FMC-A: Aluminum flexible metal conduit.
19. FMC-S: Steel flexible metal conduit.
20. FMT: Steel flexible metallic tubing.
21. FNMC: Flexible nonmetallic conduit. See LFNC.
22. HDPE: See EPEC.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.

5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.
31. MI: Mineral-insulated, metal-sheathed cable.
32. MTW: Moisture-, heat-, and oil-resistant thermoplastic cable (machine tool wiring).
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
37. NPLF: Non-power-limited fire-alarm circuit cable.
38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
39. NPLFR: Non-power-limited fire-alarm circuit riser cable.
40. NUCC: Nonmetallic underground conduit with conductors.
41. OFC: Conductive optical fiber general-purpose cable.
42. OFCG: Conductive optical fiber general-purpose cable.
43. OFCP: Conductive optical fiber plenum cable.
44. OFCR: Conductive optical fiber riser cable.
45. OFN: Nonconductive optical fiber general-purpose cable.
46. OFNG: Nonconductive optical fiber general-purpose cable.
47. OFNP: Nonconductive optical fiber plenum cable.
48. OFNR: Nonconductive optical fiber riser cable.
49. P: Marine shipboard cable.
50. PLTC: Power-limited tray cable.
51. PLTC-ER: Power-limited tray cable, exposed run.
52. PV: Photovoltaic cable.
53. RHH: Thermoset rubber, heat-resistant cable (high heat).
54. RHW: Thermoset rubber, moisture-resistant cable.

55. SA: Silicone rubber cable.
56. SE: Service-entrance cable.
57. SER: Service-entrance cable, round.
58. SEU: Service-entrance cable, flat.
59. SIS: Thermoset cable for switchboard and switchgear wiring.
60. TBS: Thermoplastic cable with outer braid.
61. TC: Tray cable.
62. TC-ER: Tray cable, exposed run.
63. TC-ER-HL: Tray cable, exposed run, hazardous location.
64. THW: Thermoplastic, heat- and moisture-resistant cable.
65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
66. THHW: Thermoplastic, heat- and moisture-resistant cable.
67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
68. TW: Thermoplastic, moisture-resistant cable.
69. UF: Underground feeder and branch-circuit cable.
70. USE: Underground service-entrance cable.
71. XHH: Cross-linked polyethylene, heat-resistant cable.
72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Definitions:

1. Basic Impulse Insulation Level: Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
2. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
3. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
4. Designated Seismic System: A system component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.
5. Direct Buried: Installed underground without encasement in concrete or other protective material.
6. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
 - a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
 - b. Concrete Box: A box intended for use in poured concrete.
 - c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 - d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
 - e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
 - f. Device Box: A box with provisions for mounting a wiring device directly to the box.
 - g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.

- h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
 - i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
 - j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
 - k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
 - l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
 - m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
 - n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
 - o. Raised-Floor Box: A floor box intended for use in raised floors.
 - p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
 - q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
 - r. Raised Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
 - s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
 - t. Sleeves: Mechanical protection for cables/conduits that pass through a wall or floor.
 - u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
7. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
 8. Essential Electrical Systems: Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system. (healthcare facilities)
 9. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
 10. Jacket: A continuous nonmetallic outer covering for conductors or cables.

11. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
12. Miniature 8-Position Series Jack (8PSJ): Also called an 8-position 8-contact (8P8C) modular jack. An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Shape and dimensions are specified by TIA-1096.
 - a. Caution: An 8PSJ is not the same thing as an FCC "registered jack" RJ45S, now called a miniature 8-position keyed jack (8PKJ). Ethernet cable plugs do not have rejection keys. Many manufacturers and suppliers incorrectly use "RJ45" as a generic term to describe any 8-position series plug or jack whether it has a rejection key or not.
13. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
14. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
15. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
16. Provide: As used in this section, "provide" shall mean, "Furnish and install". "Furnish" shall mean "to purchase and deliver to the project site complete with every necessary appurtenance and support", and "install" shall mean "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project."
17. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
18. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
19. Sheath: A continuous metallic covering for conductors or cables.
20. UL Category Control Number: An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
21. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
 - b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
 - c. Extra-Low Voltage: Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
 - d. Low Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
 - e. Medium Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
 - f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

1.3 OWNER FURNISHED PRODUCTS

- A. Products Furnished to The Site And Paid For By Owner:
 - 1. Dishwasher
 - 2. Ranges
 - 3. Clothes Washer
 - 4. Clothes Dryer

- B. Work associated with Owner Furnished Products and Provided under Division 26 where specifically indicated on drawings:
 - 1. All interconnecting wiring and all final connections as required for complete operating systems. Coordinate with the Owner for specific requirements.
 - 2. Receive delivery, store, protect, handle and place at location indicated on the drawing.
 - 3. Include all required rigging.

1.4 PROJECT/SITE CONDITIONS

- A. Coordinate with all other trades to ensure proper access and space requirements.

- B. Where project conditions occur necessitating departures from the drawings, submit for approval the details of and reasons for departures prior to implementing any change.

1.5 COORDINATION

- A. Arrange to provide temporary electrical service and power in accordance with requirements specified in Division 01.

1.6 PREINSTALLATION MEETINGS

- A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner as required in Division 01 specification, after notice to proceed. Agenda topics include, but are not limited to, the following:
 - 1. Electrical installation schedule.
 - 2. Status of power system studies.
 - 3. Value analysis proposals and requests for substitution of electrical equipment.
 - 4. Utility work coordination and class of service requests.
 - 5. Commissioning activities.

1.7 SEQUENCING

- A. Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

1.8 ACTION SUBMITTALS

- A. As a requirement of this specification, the Contractor shall participate in the development of a set of common coordination drawings for the corridors of Area B, Area C, and Area E as described in Section 013100 – Project Management and Coordination.
- B. Mechanical HVAC, plumbing, fire protection and electrical construction shall not commence until coordination drawings have been reviewed. The Contractor shall bring any coordination issues to the attention of the Architect. Review of the coordination drawings by the Architect does not relieve the Contractor of their responsibility to provide a properly coordinated construction project.
- C. Division 23 contractor shall be responsible to manage the coordination drawing effort and submit the drawings as shop drawings for review and comment. Division 23 shall develop the base floor plans and building sections and place his mechanical equipment ductwork and piping on them. They shall then coordinate and manage each Trade's effort while they place their information on the same drawings.
- D. Each trade: Division 21, 22 and 26 shall work with the Division 23 contractor to help produce the coordination drawings. Each trade shall be responsible to coordinate their own equipment, piping, conduit, tray and other associated materials with the other trades and place this information on the drawings.

1.9 INFORMATIONAL SUBMITTALS

- A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:
 - 1. Submission of power system studies.
 - 2. Submission of specified coordination drawings.
 - 3. Submission of action submittals specified in Division 26.
 - 4. Orders placed for major electrical equipment.
 - 5. Arrival of major electrical equipment on-site.
 - 6. Preinstallation meetings specified in Division 26.
 - 7. Utility service outages.
 - 8. Utility service inspection and activation.
 - 9. Mockup reviews.
 - 10. Closing of walls and ceilings containing electrical Work.
 - 11. System startup, testing, and commissioning activities for major electrical equipment.
 - 12. System startup, testing, and commissioning activities for emergency lighting.
 - 13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
 - 14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
 - 15. Requests for special inspections.
 - 16. Requests for inspections by authorities having jurisdiction.
- B. Certificates:
 - 1. Welding certificates.

2. Seismic-Load Performance Certificates: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-10, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified on Drawings or in the Specifications.
 - a. All Electrical systems and components are Designated Seismic Systems as noted below and require written special certification of seismic qualification by manufacturer.
 - 1) ASCE/SEI 7-10
 - 2) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 3) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 4) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 5) Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
 - 6) Provide equipment manufacturer's written certification for each designated active electrical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction, or experience data as permitted by ASCE/SEI 7-10.
 - 7) Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-10.
 - 8) Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by qualified structural professional engineer.

1.10 CLOSEOUT SUBMITTALS

- A. Facility EPM Program Binders:
 1. Complete Set: On USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
 2. Volumes 2 and 8: Reproducible hardcopy on archival quality, 28 lb (105 GSM), acid-free, bond paper.
- B. Operation and Maintenance Data:
 1. Provide emergency, operation, and maintenance manuals for each major system component, equipment, and device.
 2. Include the following information:
 - a. Manufacturer's operating specifications.
 - b. User's guides for software and hardware.
 - c. Schedule of maintenance material items recommended to be stored at Project site.
 - d. Detailed instructions covering operation under both normal and abnormal conditions.
 - e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
 - f. List of load-current and overload-relay heaters with related motor nameplate data.

- g. Manufacturer's instructions for setting field-adjustable components.
- C. Software and Firmware Operational Documentation: Provide software and firmware operational documentation in Facility EPM Program Binders, including the following:
 - 1. Software operating and upgrade manuals.
 - 2. Names, versions, and website addresses for locations of installed software.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Testing and adjusting of panic and emergency power features.
 - 6. For lighting controls include the following:
 - a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
 - b. Operation of adjustable zone controls.
- D. Software:
 - 1. Program Software Backup: Provide username and password for approved online or cloud solution and USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
 - 2. Provide to Owner upgrades and unrestricted licenses for installed and backup software, including operating systems and programming tools required for operation and maintenance.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

- A. Substitution requests for electrical equipment will be entertained under the following conditions:
 - 1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
 - 2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
 - 3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION

- A. Execute all work in a neat manner acceptable to the Local and State Electrical Inspector and Engineer. Follow manufacturer's installation recommendations.

- B. All electrical components and their attachments shall be properly supported and where required shall be designed for seismic forces.
- C. Lighting fixtures shall be supported from structural steel. Provide unistrut channels or equal to span between top cord of joists.
- D. Perform all electrical work by licensed electricians well skilled in the trade and supervised by a Master Electrician.
- E. Replace or repair to new condition, defective equipment and equipment damaged during installation or testing.

3.2 TESTING AND ADJUSTING

- A. The entire installation shall be free from short circuits and improper grounds. Test in the presence of the Architects or their representatives.
- B. Test feeders with the feeders disconnected from the branch circuit panels.
- C. Test each individual branch circuit at the panel. In testing for insulation resistance to ground, the power equipment shall be connected for proper operation. In no case shall the insulation resistance be less than that required by the National Electrical Code and the manufacturer's recommendations. Correct failure in a manner satisfactory to the Architect and Engineers.
- D. Completely test and adjust each system specified under Division 26 for proper operation.

3.3 SLEEVES, INSERTS AND OPENINGS

- A. Sleeves:
 1. Furnish and install all sleeves required for the work.
 2. Sleeves through exterior building walls or through concrete construction shall be rigid galvanized steel.
 3. Sleeves shall be sized to provide a total of not less than 1/2-inch clearance around conduit.
 4. Sleeves for setting into walls shall be flush with finished construction. Sleeves for setting into floor shall be embedded in concrete slab and extend approximately 2 inches above finished floors.
 5. All sleeved openings within building shall be sealed airtight using fire barrier caulking with a UL classification for use as a fire penetration seal for walls and floors with up to a 3-hour fire rating expanded.
 6. Sleeves shall be provided in all locations where cables and conduits penetrate walls and floors.
 7. Selection of firestopping materials and installation shall be in accordance with specifications

3.4 DEVELOPMENT OF FACILITY EPM PROGRAM

- A. Facility EPM Program must be developed by qualified EPM specialist.

- B. Conduct Facility EPM Program analysis in accordance with NFPA 70B recommendations.
- C. Compile operation and maintenance data from Facility EPM Program analysis and submit Facility EPM Program Binders.

3.5 INSTALLATION OF ELECTRICAL WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

3.6 FIELD QUALITY CONTROL

- A. Administrant for Low-Voltage Electrical Tests and Inspections:
 - 1. Administer and perform tests and inspections with assistance of factory-authorized service representative.
- B. Administrant for Structural Tests and Inspections:
 - 1. Owner will engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
 - 2. Engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
 - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 - 4. Administer and perform tests and inspections.
- C. Administrant for Field Tests and Inspections of Lighting Installations:
 - 1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

3.7 CLOSEOUT ACTIVITIES

- A. Demonstration:
 - 1. With assistance from factory-authorized service representatives, demonstrate to Owner's maintenance and clerical personnel and building occupants how to operate the systems and equipment:
 - 2. Record demonstrations for Owner's future use and training.
- B. Training:
 - 1. With assistance from factory-authorized service representatives as appropriate, train Owner's maintenance personnel on all applicable topics addressed within Electrical specifications.
 - 2. Record training sessions for Owner's future use.

3.8 RECORD DRAWINGS

- A. Submit under provisions of Division 01.
- B. Keep a marked set of Drawings at the site as a record set indicating all revisions in the work as the work progresses. At the completion of the work, mark the Drawings "As-Built Drawings" with the Contractor's name and date, and deliver to the Architect.

3.9 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of the latest edition of ANSI/NFPA 70 National Electrical Code (N.E.C.).
- B. Conform to requirements of all local, State and Federal laws and regulations, plus local electric utility company's rules, and the Fire Underwriters' requirements.
- C. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- D. Secure and pay for all permits and certificates as required by local, State and Federal laws.
- E. Request inspections from authority having jurisdiction.
- F. Run separate circuits for lighting and receptacle outlets as indicated.
 - 1. Circuits shall be balanced and loads and capacities shall be in accordance with requirements of local electric light company and National Board of Fire Underwriters.
 - 2. Do not share neutral on branch circuits.
- G. The entire electrical system shall be permanently and effectively grounded in accordance with Code requirements.
- H. The Drawings indicate only diagrammatically the extent, layout and the general location and arrangement of equipment, conduit and wiring. Become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment will be properly located and readily accessible.
 - 1. Note that drawings do not show all junction boxes and fixture whips for lighting fixtures recessed in accessible ceilings. Although not specifically shown on the drawings, these fixtures shall be wired from junction boxes and maximum 6'-0" unsupported whips. Provide number of junction boxes as required allowing for the maximum 6'-0" whips. Wiring from fixture to fixture is not allowed.
 - 2. Lighting and Devices shown with same panel and circuit designation with no home run symbol may share same home runs to panelboards provided that the furthest device on the circuit does not exceed 2-1/2% voltage drop.
 - 3. Where home run symbols are shown, use separate run to panelboard for each symbol, and do not share home run with other devices having same panel and circuit designation.

END OF SECTION 260010

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SECTION 260180 - EQUIPMENT WIRING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment specified under other Sections or furnished by Owner, including but not limited to: exhaust fans, air handling units, air-conditioning units, VRF ac units, branch selectors, ceiling cassettes, circulators, heating system pumps, home economics (life skills), art, industrial art.
- B. All line voltage wiring including final branch circuit connections to disconnects, motor controllers, Variable Frequency Drives (VFD), Isolation transformers, and motors. See Equipment Schedules on Drawings for wiring and plans for equipment locations.
- C. Fused and non-fused disconnect switches for the equipment, except disconnect switches specifically provided with the equipment.
- D. Except as specifically noted, motors, variable frequency drives (VFD), isolation transformers for VFD, magnetic or manual starters and thermal overload protection will be furnished with the equipment for installation under Division 26 Section 260180.
 - 1. Single pole switches, switch and pilots, and light/fan switches shall be provided and installed under Division 26 Section 260180. Coordinate with equipment schedules on H&V Drawings.
- E. Temperature Control Wiring: Provided and installed under Division 23 Section "Instrumentation and Controls for HVAC Systems".
- F. Roof Top Equipment: Whether shown or not on the Drawings, provide a weather proof GFCI service receptacle at units per code requirements. For 120 volt, 15 and 20 amp equipment, connect to line side of safety switch. For larger equipment, provide home run to nearest 120 volt, 20A, 1 pole spare breaker. Label and show on as-built drawings.

1.2 RELATED SECTIONS

- A. Division 01 Section "Summary".
- B. Division 22 Section "Plumbing".
- C. Division 23 Section "Heating Ventilation and Air Conditioning".
- D. Division 26 Section "Basic Electrical Requirements".

1.3 REFERENCES

- A. NEMA Standards.
- B. NFPA 70 (N.E.C.) Latest Edition.
- C. U.L. Standards.

- D. ANSI Standards.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70. (N.E.C.)
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- C. Drawings do not show all required disconnect servicing switches. Furnish and locate as required by N.E.C.
- D. Size fuses and thermal elements per N.E.C. and manufacturer's recommendations.
- E. Connect motors for correct voltage, phase and rotation.

1.5 SUBMITTALS

- A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".
- B. Include wiring connections, special outlets.

PART 2 - PRODUCTS

- 2.1 DISCONNECT SWITCHES: Specified under Division 26 Section 262816 Enclosed Switches and Circuit Breakers.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 PREPARATION

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.3 INSTALLATION

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment, but in no case less than the wire specified under Division 26 Section 260519 "Low-voltage electrical power conductors and cables."
- B. Conduit Connections to Equipment: Dry locations, use flexible conduit. Damp or wet locations, use flexible liquidtight Type UA conduit with approved liquidtight fittings. Maximum length two feet (2').

- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Semiportable Machines: Use heavy-duty oil-resistant type SO cord with stranded copper conductors No. 12 AWG, minimum size and number of wires as required to include each phase conductor, white neutral conductor, and green grounding conductor. Furnish and install Kellems Series H cord grips and spring hangers for each cord connected machine with overhead supply.
- F. Make wiring connections in wiring compartment of prewired equipment in accordance with manufacturer's instructions.
- G. Install disconnect switches, controllers, control stations, temperature switches as indicated or required.

END OF SECTION 260180

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copper building wire.
 - 2. Metal-clad cable, Type MC.
 - 3. Fire-alarm wire and cable.
 - 4. Connectors and splices.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Division 27.
 - 3. Division 28.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product, including construction, diameter, ampacity and bending radius.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated, and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less. All feeders sized based on copper conductor ampacity.
- B. Manufacturers:
 - 1. General Cable
 - 2. Superior Essex Inc.
 - 3. Southwire Company
 - 4. Allied Wire & Cable
 - 5. Cerro Wire

6. AFC Cable Systems
7. Encore Wire Corporation
8. Approved Equal

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
3. Type XHHW-2: Comply with UL 44.

2.2 NONMETALLIC SHEATH CABLE – NOT ALLOWED

2.3 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers:

1. General Cable
2. Superior Essex Inc.
3. Southwire Company
4. Allied Wire & Cable
5. Cerro Wire
6. AFC Cable Systems
7. Encore Wire Corporation
8. Approved Equal

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Maximum #10 AWG, Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

- F. Ground Conductor: Separate; Insulated.
- G. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2 rated 600V, 90° C: Comply with UL 83.
- H. Armor: Steel or Aluminum, interlocked.

2.4 FIRE-ALARM WIRE AND CABLE

- A. Manufacturers:
 - 1. Anixter
 - 2. Superior Essex Inc.
 - 3. Southwire Company
 - 4. Allied Wire & Cable
 - 5. AFC Cable Systems
 - 6. Encore Wire Corporation
 - 7. Approved Equal
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer, no smaller than No. 16 AWG.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.
- E. Cable Type: Type MC marked for Fire Alarm use.

2.5 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers:
 - 1. General Cable
 - 2. Superior Essex Inc.
 - 3. Southwire Company
 - 4. Allied Wire & Cable
 - 5. Cerro Wire
 - 6. AFC Cable Systems
 - 7. Encore Wire Corporation

- 8. Approved Equal
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper, or Aluminum.
 - 2. Type: One or Two hole with standard or long barrels as appropriate.
 - 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 - 1. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits:
 - 1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: XHHW/XHHW-2 single conductor in raceway.
- B. Exposed Feeders (use only where indicated on drawings): Type XHHW-2, single conductors in raceway (only in mechanical spaces).
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type XHHW/XHHW-2 single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace (if indicated on drawings): Type THHN/THWN-2, single conductors in raceway, Metal-clad cable, Type MC.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway, Metal-clad cable, Type MC.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW/XHHW-2, single conductors in raceway. Type XHHW-2, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION, GENERAL

- A. All conductors on drawings are sized for Copper.
- B. Except as otherwise specifically noted, all wiring throughout the building, including each of the systems specified, shall be enclosed in raceways.
- C. Unless specifically noted on drawings, wire sizes have not been derated. Where multiple circuits are installed in one conduit, appropriate deration of wire size in accordance with 310.15 must be accounted for.
- D. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- E. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- F. 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.
- G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- H. Pull all conductors into raceway at same time.
- I. Use suitable wire pulling lubricant for building wire #4 AWG and larger.
- J. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- K. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway.
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
 - 4. Signaling Line Circuits: Power-limited fire-alarm cables may not be installed in the same cable or pathway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess.

Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.
- F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.
- G. Wiring to Remote Alarm Transmitting Device: 1 inch (25 mm) conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

- A. 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-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Clean conductor surfaces before installing lugs and connectors.
- D. Use split bolt connectors, insulation piercing connectors or U.L. approved insulated connectors for copper conductor splices and taps, #6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- E. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, #8 AWG and smaller.
- F. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- G. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch (150 mm) of slack.
- H. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07.

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and all conductors over #8AWG for compliance with requirements.
 - a. Insulation Resistance test:
 - 1) Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable.
 - 2) Take readings after 1 minute and until the reading is constant for 15 seconds.
 - 3) Minimum insulation-resistance values shall not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
 - 3. Inspect all wire and cable for:
 - a. Physical damage and proper connection.

- b. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
 - c. Verify continuity of each branch circuit conductor.
 - d. Verify proper operation of each circuit.
4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. 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.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
- 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Grounding and bonding conductors.
 - 2. Grounding and bonding clamps.
 - 3. Grounding and bonding bushings.
 - 4. Grounding and bonding hubs.
 - 5. Grounding and bonding connectors.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product indicated.
- B. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control" Article.

1.3 CLOSEOUT SUBMITTALS

- A. Manufacturer's Instructions: Include Instructions for protection, examination, preparation, and installation of exothermic connectors.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment Grounding Conductor:
 - 1. General Characteristics: 600 V, THHN/THWN-2 copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. ASTM - Bare Copper Grounding and Bonding Conductor:
 - 1. Erico, Eritech, Caltrain, Grainer, or approved equal
 - 2. Referenced Standards: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.

- c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
- d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

2.2 GROUNDING AND BONDING CLAMPS

- A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications; for selection and installation guidelines.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- D. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:
 - 1. Thomas and Betts/Blackburn, or approved equal.
 - 2. General Characteristics:
 - a. Two pieces with stainless steel bolts.
 - b. Clamp Material: Silicon bronze.
 - c. Listed for outdoor use.
- E. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp:
 - 1. Thomas and Betts/Blackburn, or approved equal.
 - 2. General Characteristics:
 - a. Clamp Material: Brass.
 - b. Listed for outdoor use.
- F. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp:
 - 1. Thomas and Betts/Blackburn, or approved equal.
 - 2. General Characteristics:
 - a. Clamp Material: Copper.
 - b. Listed for outdoor use.
- G. UL KDER - Beam Grounding and Bonding Clamp:
 - 1. Thomas and Betts/Blackburn, or approved equal.
 - 2. General Characteristics: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.
- H. UL KDER - Exothermically Welded Connection:
 - 1. Erico, Cadweld, or approved equal.
 - 2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- D. UL KDER - Bonding Bushing:
 - 1. Bridgeport, Eaton, or approved equal.
 - 2. General Characteristics: Threaded bushing with insulated throat.
- E. UL KDER - Grounding Bushing:
 - 1. Bridgeport, Eaton, or approved equal.
 - 2. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.4 GROUNDING AND BONDING HUBS

- A. Description: Hubs with certified grounding or bonding locknut.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- D. UL KDER - Grounding and Bonding Hub:
 - 1. Bridgeport, Eaton, or approved equal.
 - 2. General Characteristics: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

2.5 GROUNDING AND BONDING CONNECTORS

- A. Source Limitations: Obtain products from single manufacturer.

- B. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- C. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal:
 - 1. Thomas and Betts/Blackburn, or approved equal.
 - 2. General Characteristics: Mechanical-type, copper rated for direct burial terminal with set screw.
- D. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal:
 - 1. Thomas and Betts/Blackburn, or approved equal.
 - 2. General Characteristics: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on 5/8 or 1 inch (16 or 25 mm) centers for two-bolt connection to busbar.

2.6 GROUNDING (EARTHING) ELECTRODES

- A. Description: Grounding electrodes include rod electrodes, ring electrodes, metal underground water pipes, metal building frames, concrete-encased electrodes, and pipe and plate electrodes.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Proceed with connection of electrical equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING CONDUCTORS

- A. Conductors: Install solid conductor for **8 AWG** and smaller, and stranded conductors for **6 AWG** and larger unless otherwise indicated.
- B. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand.
- C. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch (6 mm) in diameter.
- D. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
- E. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
- F. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
- G. Underground Grounding Conductors: Install bare copper conductor, 4/0 AWG minimum.

3.3 SELECTION OF CONNECTORS

- A. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Connections to Structural Steel: Welded connectors.

3.4 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:
 - 1. Conductors:
 - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 - 2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

- 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
- 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
- g. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- 3. Equipment Grounding:
 - a. Provide separate, insulated 600V conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
 - b. Equipment grounding conductors shall be continuous where possible. Where splices are required, provide approved compression connectors in an approved pattern. Insulate connectors to equivalent thickness of conductors.
 - c. 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.
 - d. 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.
 - e. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
 - f. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
 - g. Metallic Fences: Comply with requirements of IEEE C2.
 - 1) Grounding Conductor: Bare copper, not less than 12 AWG.
 - 2) Barbed Wire: Strands must be bonded to grounding conductor.

3.5 FIELD QUALITY CONTROL

- A. Field tests and inspections shall be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.

3.6 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Support, anchorage, and attachment components.
 - 2. Fabricated metal equipment support assemblies.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.
- B. SHOP DRAWINGS:
 - 1. Hangers. Include product data for components.
 - 2. Slotted support systems.
 - 3. Equipment supports.
 - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
 - 1. Flexstrut, Unistrut, or approved equal.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 4. Channel Width: Selected for applicable load criteria.
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
 - 1. Flexstrut, Unistrut, Graybar, or approved equal.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Channel Material: 6063-T5 aluminum alloy.
 - 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- C. Conduit and Cable Support Devices: Steel, Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

- F. 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, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325 (Grade A325M).
5. Toggle Bolts: Steel springhead type.
6. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA NEIS 101
 2. NECA NEIS 102.
 3. NECA NEIS 105.
- B. Comply with requirements in Division 07 for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes as specified in Section 260533 "Raceway and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch (6 mm) in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps.

3.2 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: As described in NECA NEIS 1, EMT, IMC and ERMC.
- C. 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 must be weight of supported components plus 200 lb (90 kg).

- D. 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.
 - 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.
 - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69, Spring-tension clamps.
 - 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 by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements 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. Submit welding certificates.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inch (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000 psi (20.7 MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 - 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.

3.5 PAINTING

A. Touchup:

1. 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.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

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SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT-S raceways and elbows.
2. Type ERMC-A and Type ERMC-SS raceways, elbows, couplings, and nipples.
3. Type ERMC-S raceways, elbows, couplings, and nipples.
4. Type FMT raceways.
5. Type IMC raceways.
6. Fittings for conduit, tubing, and cable.
7. Threaded metal joint compound.
8. Solvent cements.
9. Wireways and auxiliary gutters.
10. Metallic outlet boxes, device boxes, rings, and covers.
11. Termination boxes.
12. Junction boxes, pull boxes, and miscellaneous enclosures.
13. Cover plates for device boxes.
14. While in use cover for exterior receptacles.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Division 27 for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets serving communications systems.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.
2. Surface metal raceways.
3. Floor boxes.
4. Cabinets, cutout boxes, and miscellaneous enclosures.
5. Expansion Fittings.
6. Fire-stop seals and fillers.
7. Boxes larger than 12x12x6 inches
8. Boxes with hinged covers

B. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures."

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions:
 - 1. For Type ERM-C-S-PVC.

1.4 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.
- B. Accurately record actual locations and mounting heights of outlets if not as shown on Drawings, plus pull and junction boxes larger than 12"x12"x6" and boxes used for panel feeders.
- C. Accurately record routing of all underground and other conduits 2" and larger.

1.5 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify locations of boxes and outlets in work areas prior to rough in.
- C. Verify routing and termination locations of conduit prior to rough-in.
- D. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Generally, pull boxes are not shown on Drawings. Provide as required.
- E. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to meet project conditions.
- F. Where conduit routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.6 COORDINATION

- A. Locate outlets so that they are readily accessible and do not interfere with other work.
- B. Provide access panels where required.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Division 01.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

PART 2 - PRODUCTS

2.1 TYPE EMT-S RACEWAYS AND ELBOWS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 797 and UL Category Control Number FJMX.
- B. Steel Electrical Metal Tubing (EMT-S) and Elbows:
 - 1. Material: Steel.
 - 2. Options:
 - a. Exterior Coating: Zinc
 - b. Interior Coating: Zinc
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - d. Colors: As indicated on Drawings. (Red for Fire Alarm)

2.2 TYPE ERMC-A AND TYPE ERMC-SS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 6A and UL Category Control Number DYWV.
- B. Aluminum Electrical Rigid Metal Conduit (ERMC-A), Elbows, Couplings, and Nipples:
 - 1. Material: Aluminum.
 - 2. Options:
 - a. Protective Coating: Provide protective coating for use in severely corrosive environment.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - c. Colors: As indicated on Drawings.

2.3 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 6 and UL Category Control Number DYIX.
- B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
 - 1. Allied Tube & Conduit, Wheatland.
 - 2. Exterior Coating: Zinc.
 - 3. Options:

- a. Interior Coating: Zinc.
- b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- c. Colors: As indicated on Drawings.

2.4 TYPE FMT RACEWAYS

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 1652 and UL Category Control Number ILJW.
 3. Utilize FMC for permanent connections to motors.
- B. Steel Flexible Metallic Tubing (FMT):
 1. Allied Tube & Conduit Wheatland, or approved equal
 2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Colors: As indicated on Drawings.

2.5 TYPE IMC RACEWAYS

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 1242 and UL Category Control Number DYBY.
- B. Steel Electrical Intermediate Metal Conduit (IMC):
 1. Allied Tube & Conduit, Wheatland, or approved equal
 2. Options:
 - a. Exterior Coating: Zinc.
 - b. Interior Coating: Zinc.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - d. Colors: As indicated on Drawings.

2.6 TYPE LFMC RACEWAYS

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 360 and UL Category Control Number DXHR.
 3. Utilize type LFMC Conduit for connection to motors in damp or wet locations.
- B. Steel Liquidtight Flexible Metal Conduit (LFMC-S):
 1. Wheatland, Allied Tube & Conduit, or approved equal
 2. Material: Steel.
 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Colors: As indicated on Drawings.

- C. Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):
 - 1. Wheatland, Allied Tube & Conduit, or approved equal
 - 2. Material: Stainless steel.
 - 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Colors: As indicated on Drawings.

2.7 TYPE PVC RACEWAYS AND FITTINGS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 651 and UL Category Control Number DZYR.
- B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:
 - 1. Carlon or approved equal
 - 2. Dimensional Specifications: Schedule 40.
 - 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Markings: For use with maximum 90 deg C wire.
- C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
 - 1. Carlon or approved equal
 - 2. Dimensional Specifications: Schedule 80.
 - 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Markings: For use with maximum 90 deg C wire.

2.8 FITTINGS FOR CONDUIT, TUBING, AND CABLE

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- B. Fittings for Type ERM, Type IMC, Type PVC, Raceways:
 - 1. Wheatland, Allied Tube & Conduit, or approved equal
 - 2. General Characteristics: UL 514B and UL Category Control Number DWTT.
 - 3. Options:
 - a. Material: Steel.
 - b. Coupling Method: Threaded coupling.
 - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.
- C. Fittings for Type EMT Raceways:
 - 1. Wheatland, Allied Tube & Conduit, or approved equal
 - 2. General Characteristics: UL 514B and UL Category Control Number FKAV.
 - 3. Options:
 - a. Material: Steel.

- b. Coupling Method: Compression coupling, RACO, Crouse-hinds, Raintight compression coupling with distinctive color gland nut Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
 - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.
 - D. Fittings for Type FMC Raceways:
 - 1. Wheatland, Allied Tube & Conduit, or approved equal
 - 2. General Characteristics: UL 514B and UL Category Control Number ILNR.
 - E. Fittings for Type LFMC and Type LFNC Raceways:
 - 1. Wheatland, Allied Tube & Conduit, or approved equal
 - 2. General Characteristics: UL 514B and UL Category Control Number DXAS.
- 2.9 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT
- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 2419 and UL Category Control Number FOIZ.
- 2.10 SOLVENT CEMENTS
- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL Category Control Number DWTT.
 - B. Solvent Cements for Type PVC Raceways and Fittings:
 - 1. Carlon, or approved equal.
- 2.11 WIREWAYS AND AUXILIARY GUTTERS
- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 870 and UL Category Control Number ZOYX.
 - B. Metal Wireways and Auxiliary Gutters:
 - 1. General Electric, Square D., Siemens or approved equal.
 - 2. Additional Characteristics:
 - a. 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.
 - b. Finish: Manufacturer's standard enamel finish.
 - c. Minimum size 6"x6" length.

3. Options:
 - a. Degree of Protection: Type 1 unless otherwise indicated.
 - b. Wireway Covers: Hinged type unless otherwise indicated.

2.12 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 514A and UL Category Control Number QCIT.
3. Covers for flush floor devices and poke-through fittings shall meet UL scrub water standards for installation in carpet and tile floors.

B. Metallic Outlet Boxes:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
2. Hubbell, RACO, Legrand, or approved equal.
3. Options:
 - a. Material: Sheet steel.
 - b. Sheet Metal Depth: Minimum 2.125 inches.
 - c. Size 4 inch by 4 inch.
 - d. Cast-Metal Depth: Minimum 2.4 inch (60.3 mm).
 - e. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb (23 kg).

C. Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
2. Hubbell, Leviton, Legrand, or approved equal.

D. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.
2. Hubbell, RACO, Legrand, or approved equal.
3. Options:
 - a. Material: Sheet steel.
 - b. Sheet Metal Depth: minimum 2.125 inches.
 - c. 4 inch x 4 inch square box.

E. Metallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
2. Hubbell, Raco, Leviton, Legrand, or approved equal.
3. For flush installations.

2.13 JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. Non-Environmental Characteristics: UL 50.
 - b. Environmental Characteristics: UL 50E.
- B. Indoor Sheet Metal Junction and Pull Boxes:
 - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - 2. Hubbell, Hoffman, or approved equal
 - 3. Additional Characteristics: UL Category Control Number BGUZ.
 - 4. Options:
 - a. Degree of Protection: Type 1
- C. Indoor Cast-Metal Junction and Pull Boxes:
 - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - 2. Hubbell, or approved equal
 - 3. Additional Characteristics: UL Category Control Number BGUZ.
 - 4. Options:
 - a. Degree of Protection: Type 1

2.14 WHILE IN USE COVER FOR EXTERIOR OUTLET BOXES

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. Reference Standards:
 - 1) UL 514D and UL Category Control Numbers QCIT and QCMZ.
 - 2) Receptacle, while in use cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
 - b. Mounts to box using fasteners different from wiring device.
- B. Retractable or Reattachable While in Use Cover for Outlet Boxes:
 - 1. Options:
 - a. Provides **clear**, weatherproof, "while-in-use" cover.

PART 3 - EXECUTION

3.1 SELECTION OF RACEWAYS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.
- B. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
 - 1. ERM and IMC: Provide threaded type fittings unless otherwise indicated.

3.2 SELECTION OF BOXES AND ENCLOSURES

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

3.3 INSTALLATION OF RACEWAYS

- A. Installation Standards:
 - 1. Install exposed only where specifically indicated.
 - 2. Arrange supports to prevent misalignment during wiring installation.
 - 3. Route conduit parallel and perpendicular to walls.
 - 4. Do not cross conduits in slab.
 - 5. Route conduit in and under slab from point-to-point.
 - a. Conduit larger than 3/4" shall be run under slab.
 - b. Raise through slab in rigid galvanized steel conduit.
 - 6. Maintain adequate clearance between conduit and piping.
 - 7. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
 - 8. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
 - 9. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.
 - 10. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
 - 11. Use sleeves when passing through floors and walls.
 - 12. When serving roof top equipment, conduit shall enter within the weather-proof curbing. Maintain watertight roofing system.
 - 13. Ground and bond conduit under provisions of Division 26 Section "Grounding and Bonding."
 - 14. Identify conduit under provisions of Division 26.
 - 15. Group Related Conduits:
 - a. Support using conduit rack of Power-Strut or approved equal.
 - b. Parallel runs shall be neatly clustered with all bends and offsets of uniform pattern.
 - c. Provide space on each for 25 percent additional conduit.
 - 16. Substantially support conduits with approved clips or hangers spaced not to exceed ten feet (10') on centers except 1/2" rigid conduit and 1/2" and 3/4" electrical metallic tubing shall have supports spaced not to exceed six feet (6').

17. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.
18. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
19. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
20. Comply with NECA NEIS 101 for installation of steel raceways.
21. Comply with NECA NEIS 102 for installation of aluminum raceways.
22. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
23. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
24. Raceway Terminations at Locations Subject to Moisture or Vibration:
 - a. Provide insulating bushings or insulated throat connectors in accordance with code requirements to protect conductors, including conductors smaller than No. 4 AWG. Install insulated throat metal grounding bushings on service conduits.

B. General Requirements for Installation of Raceways:

1. Complete raceway installation before starting conductor installation.
2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft (0.6 m) above finished floor.
3. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch (300 mm) of changes in direction.
4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
6. Support conduit within 12 inch (300 mm) of enclosures to which attached.
7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
8. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes, before burying in trench.
9. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - b. Where an underground service raceway enters a building or structure.
 - c. Conduit extending from interior to exterior of building.

- d. Conduit extending into pressurized duct and equipment.
 - e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - f. Where otherwise required by NFPA 70.
10. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.
 11. Do not install conduits within 2 inch (50 mm) of the bottom side of a metal deck roof.
 12. Keep raceways at least 6 inch (150 mm) away from parallel runs of flues and steam, hot-water pipes, or any surface exceeding a surface temperature of 104°F. Install horizontal raceway runs above water and steam piping.
 13. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
 14. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb (90 kg) tensile strength. Leave at least 12 inch (300 mm) of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

C. Expansion-Joint Fittings:

1. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F (17 deg C) and that have straight-run length that exceeds 25 ft (7.6 m). Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F (55 deg C) and that have straight-run length that exceeds 100 ft (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at locations where conduits cross building or structure expansion joints.
5. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

3.4 INSTALLATION OF BOXES AND ENCLOSURES

- A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.

- B. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
 - 1. Except where specifically noted, boxes on finished surfaces shall be flush mounted with finished cover plate.
 - 2. Consult Architect prior to installing in finished areas.
 - 3. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- D. In Non-accessible Ceiling Areas: Install outlet and junction boxes **no more than 12 inches** from ceiling access panels or from removable recessed luminaires such that they are accessible.
- E. In accessible Ceiling Areas: Install outlet and junction boxes such that they are accessible from ceiling access panels or from removable recessed luminaires.
- F. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- G. 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. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
- H. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- I. Locate boxes so that cover or plate will not span different building finishes.
- J. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
- K. Support boxes from more than one side by spanning two framing members.
- L. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
- M. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
- N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
- O. Use 4" square box with plaster ring for single or double device outlets.
- P. Use cast outlet box in exterior locations **exposed to the weather** and wet locations.

3.5 FIELD QUALITY CONTROL

- A. No wire shall be installed until work which might cause damage to wires or conduits has been completed.
- B. Conduits shall be thoroughly cleaned of water or other foreign matter before wire is installed.

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING

- A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION 260533

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Pourable sealants.
6. Foam sealants.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Division 07 for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. Armstrong, Garlock or approved equal
2. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Cast-Iron Wall Sleeves:

1. Armstrong, Garlock or approved equal
2. General Characteristics: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. PVC Pipe Sleeves:

1. Carlon or equal.
2. General Characteristics: ASTM D1785, Schedule 40.

D. PVC Molded Sleeves:

1. Platt Electric Supply, Carlon, or approved equal.

2. General Characteristics: With nailing flange for attaching to wooden forms.
- E. Round, Galvanized-Steel, Sheet Metal Sleeves:
1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch (0.6 mm); round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 SLEEVE-SEAL SYSTEMS

- A. Metraflex, Roxtec, or approved equal.
- B. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
- C. Options:
1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel or Fiber-reinforced plastic or Stainless steel.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Metraflex, Garlock, or approved equal.
- B. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

- A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.5 POURABLE SEALANTS

- A. Performance Criteria:
1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 - a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4 inch (6.4 mm) annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- E. Underground, Exterior-Wall and Floor Penetrations:
 - 1. Install steel or cast-iron pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch (25 mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.

3.2 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 260544

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Labels.
 - 2. Bands and tubes.
 - 3. Tapes and stencils.
 - 4. Tags.
 - 5. Signs.
 - 6. Cable ties.
 - 7. Miscellaneous identification products.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags; and the following:
 - 1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.
 - 2. Ceiling-mounted hangers, supports, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft (2.3 m) above finished floor.
- C. Signs, labels, and tags required for personnel safety must comply with the following standards:
 - 1. Safety Colors: NEMA Z535.1.
 - 2. Facility Safety Signs: NEMA Z535.2.

3. Safety Symbols: NEMA Z535.3.
 4. Product Safety Signs and Labels: NEMA Z535.4.
 5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.
- D. Comply with NFPA 70E Arc-Flash Hazard Analysis requirements for arc-flash warning labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 1000 V or Less:
1. Black letters on orange field.
 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.
 2. Colors for 208Y/120 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 3. Colors for 240 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Neutral: White
 4. Colors for 480Y/277 V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray
 5. Color for Equipment Grounds: Green.
 6. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Warning Label Colors:
1. Identify system voltage with black letters on orange background.
- D. Warning labels and signs must include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

3. Multiple Equipment Voltages: “DANGER – MULTIPLE VOLTAGE SOURCES. ISOLATE ALL SOURCES BEFORE SERVICING”
 4. Arc Flash Hazard: “WARNING – ARC FLASH AND SHOCK HAZARD. APPROPRIATE PPE AND TOOLS REQUIRED WHEN WORKING ON THIS EQUIPMENT.”
- E. Equipment Identification Labels:
1. Black letters on white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends. Minimum ¼ inch black letters on white background.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action. Minimum ¼ inch black letters on white background.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3 mil (0.08 mm) thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend. Minimum ¼ inch black letters on white background.
 2. Marker for Labels:
 - a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3 mil (0.08 mm) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inch (37 by 150 mm) for raceway and conductors.
 - b. 3-1/2 by 5 inch (76 by 127 mm) for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

Utilize bands and tubes only where conductors are not available in colors indicated, due to size, prewired cable, or other reason: Install identifying bands ¾” wide of appropriate colors as noted in this specification within six inches (6”) and twelve inches (12”) of each end and at a maximum of five foot (5’) intervals along wireways, at back of panelboards, and wherever conductors are accessible.

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.

- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F (93 deg C). Comply with UL 224.

2.5 TAPES AND STENCILS

Use tape labels only for identification of individual wall switches, receptacles, and control device stations.

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil (0.08 mm) thick by 1 to 2 inch (25 to 50 mm) wide; compounded for outdoor use.
- C. Floor Marking Tape: 2 inch (50 mm) wide, 5 mil (0.125 mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
- D. Underground-Line Warning Tape:
 - 1. Tape:
 - a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape must be permanent and may not be damaged by burial operations.
 - c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 2. Color and Printing:
 - a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
 - b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW"
 - c. Inscriptions for Orange Tapes: CAUTION BURIED COMMUNICATION LINE BELOW
 - 3. Tape Type I:
 - a. Pigmented polyolefin, bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch (75 mm).
 - c. Thickness: 4 mil (0.1 mm).
 - d. Weight: 18.5 lb/1000 sq. ft (9.0 kg/100 sq. m).
 - e. Tensile in accordance with ASTM D882: 30 lbf (133.4 N) and 2500 psi (17.2 MPa).
 - 4. Tape Type II:
 - a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch (75 mm).
 - c. Thickness: 12 mil (0.3 mm).
 - d. Weight: 36.1 lb/1000 sq. ft (17.6 kg/100 sq. m).
 - e. Tensile in accordance with ASTM D882: 400 lbf (1780 N) and 11,500 psi (79.2 MPa).

2.6 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch (0.38 mm) thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
 - a. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

- A. Baked-Enamel Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4 inch (6.4 mm) grommets in corners for mounting.
 - 3. Nominal Size: 7 by 10 inch (180 by 250 mm).
- B. Metal-Backed Butyrate Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch (1 mm) galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
 - 2. 1/4 inch (6.4 mm) grommets in corners for mounting.
 - 3. Nominal Size: 10 by 14 inch (250 by 360 mm).
- C. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. inch (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
 - b. For signs larger than 20 sq. inch (129 sq. cm), 1/8 inch (3.2 mm) thick.
 - c. Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting or Self-adhesive.
 - d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
 - 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. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

- G. All circuit conductors of the same color shall be connected to the same ungrounded feeder conductor throughout the installation.
- H. Conductors of different system voltage shall not enter the same raceway, box, gutter, or other types of enclosures unless specifically noted on drawings or by equipment manufacturer. If required, utilize alternate wire color coding for neutrals noted in this specification.
- I. Power and lighting circuits in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection: Provide wire markers on each conductor and Identify with branch circuit or feeder number.
- J. For system control wires at control panel and load connection, provide wire markers on each conductor and identify with number as indicated on manufacturer's schematic and interconnection diagrams or manufacturer's shop drawings.
- K. For Addressable Fire Alarm System: Coordinate with fire alarm specification Section 284621.11.
- L. System Identification for Raceways and Cables under 1000 V: Identification must completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- M. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- N. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for power transfer.
- O. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- P. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:
 - 1. POWER
 - 2. FIRE ALARM
- Q. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- R. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.
- S. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.
- T. Self-Adhesive Labels:
 - 1. Install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.

2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high label; where two lines of text are required, use labels 2 inch (50 mm) high.
- U. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.
- V. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.
- W. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- X. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.
1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- Y. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- Z. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- AA. Metal Tags:
1. Place in location with high visibility and accessibility.
 2. Secure using appropriate cable ties.
- BB. Nonmetallic Preprinted Tags:
1. Place in location with high visibility and accessibility.
 2. Secure using appropriate cable ties.
- CC. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
 2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on minimum 1-1/2 inch (38 mm) high sign; where two lines of text are required, use signs minimum 2 inch (50 mm) high.
- DD. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
 2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high sign; where two lines of text are required, use labels 2 inch (50 mm) high.
- EE. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
 2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high sign; where two lines of text are required, use labels 2 inch (50 mm) high.

- FF. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120V to Ground: Identify with self-adhesive raceway labels or vinyl tape applied in bands.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify cover of junction and pull box of the following systems with self-adhesive labels containing wiring system legend and system voltage. System legends must be as follows:
 - 1. POWER
 - 2. FIRE ALARM
- E. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes or self-adhesive labels with conductor designation.
- H. Conductors to Be Extended in Future: Attach marker tape to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

- K. +Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- L. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Controls with external control power connections.
- N. Arc Flash Warning Labeling: Self-adhesive labels.
- O. Operating Instruction Signs: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs.
- P. Emergency Operating Instruction Signs: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs with white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for +power transfer.
- Q. Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign or Stenciled legend 4 inch (100 mm) high.
 - 3. Equipment to Be Labeled: (Designation, source, voltage)
 - a. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchboards.
 - e. Transformers: Label that includes tag designation indicated on Drawings for transformer source fed from feeder, and panelboards or equipment supplied by secondary.
 - f. Substations.
 - g. Emergency system boxes and enclosures.
 - h. Enclosed switches.
 - i. Enclosed circuit breakers.
 - j. Push-button stations.
 - k. Power-transfer equipment.
 - l. Contactors.
 - m. Remote-controlled switches, dimmer modules, and control devices.
 - n. Power-generating units.
 - o. Monitoring and control equipment.

END OF SECTION 260553

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Disconnecting and overcurrent protective devices.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. GFEP: Ground-fault equipment protection.
- B. MCCB: Molded-case circuit breaker.
- C. VPR: Voltage protection rating.
- D. SPD: Surge Protection Device.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Power panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 5. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 8. Include wiring diagrams for power, signal, and control wiring.
 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.
- C. Field Quality-Control Submittals:
1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- B. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
1. Recommended procedures for installing panelboards.
 2. Recommended torque settings for bolted connections on panelboards.
 3. Recommended temperature range for energizing panelboards.
- C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. **Include the following:**
1. Keys: 1 key for each panel and two spares for each type of panelboard cabinet lock. All panels shall be keyed alike or to Owners keying system.
 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards.
- B. Handle and prepare panelboards for installation in accordance with NEMA PB 1.

1.8 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PANELBOARDS CENTERS COMMON REQUIREMENTS

- A. 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.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Flush mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: UL 50E, Type 1
 - 2. Height: 7 ft (2.13 m) maximum.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
 - 4. Finishes:
 - a. Panels and Trim: 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: Galvanized steel.
- F. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating must run entire length of bus.
 - b. Bus must be fully rated for entire length.
 - c. Sub-feed and feed-through lugs designed for use for both copper and aluminum conductors. Sub-feed shall signify that lugs are tapped ahead of buses and feed-through shall signify that lugs are tapped on load side of the main and buses.
 - 2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.

5. Do not mount neutral bus in gutter.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
 2. Terminations must allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- H. Future Devices: Panelboards must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Minimum Percentage of Future Space Capacity: 20 percent.
- I. Panelboard Short-Circuit Current Rating:
1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.
 - a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.
- J. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD Type 2.
- 2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS (225 amp, 10 amp, and 100 amp)
- A. Eaton Cutler Hammer, I-T-E Siemens, General Electric, Square D, or approved equal.
 - B. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.
 - C. Mains: as indicated on drawings.
 - D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
 - E. Doors: Door-in-door construction with concealed hinges; secured with flush or multipoint latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door

must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

- F. Factory-Installed, Integral SPD (TVSS) as scheduled on drawings:
 - 1. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than 100 kA Peak surge current rating must be arithmetic sum of ratings of individual MOVs in given mode.
 - 2. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 208Y/120 V, three-phase, four-wire circuits may not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - b. Line to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - c. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - d. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
 - 3. SCCR: Equal to SCCR of panelboard in which installed.
 - 4. Inominal Rating: 22 kA.

- G. Buses:
 - 1. Copper phase and neutral buses; 100 percent capacity neutral bus and lugs.
 - 2. Copper equipment and isolated ground buses.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Eaton/Cutler Hammer, I-T-E/Siemens, ABB/General Electric, Schneider Electric/Square D, or approved equal.

- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents for fully rated system, (series connected rating is not acceptable).
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
 - 3. GFEP Circuit Breakers: Class B ground-fault protection (30 mA trip).
 - 4. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
 - 5. Subfeed Circuit Breakers: Vertically mounted.
 - 6. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - f. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

- h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.4 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards in accordance with NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

2.5 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 1.1.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Equipment Mounting:
 - a. Attach panelboard to vertical finished or structural surface behind panelboard.
 - b. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.
 - 2. Mount top most circuit breaker, no more than 79 inches above finished floor unless otherwise indicated on drawings.
 - 3. Mount panelboard cabinet plumb and rigid without distortion of box.
 - 4. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
 - 5. Install overcurrent protective devices and controllers not already factory installed.
 - a. Set field-adjustable, circuit-breaker trip ranges.
 - b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.
 - 6. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
 - 7. Install filler plates in unused spaces.
 - 8. Stub four 1 inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future.

9. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- D. Interfaces with Other Work:
1. 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.

2.6 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.
- D. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.
- E. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- F. Circuit Directory:
 1. Provide typed or computer generated directory card inside panelboard door, mounted in transparent card holder or metal frame with transparent protective cover.
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
 2. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

2.7 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
 - a. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent.
 - b. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection:

1. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections all bolted connections.
Stub 4 empty one-inch conduits to accessible location above, ceiling and below floor, from each recessed panelboard that has accessible ceilings above and/or below the panel.
2. Provide completed Hazard Warning Labels mounted on each panel.
3. Finish painting of flush panelboards and individually mounted breakers shall be as specified in Division 09 Section "Painting".
4. Properly support backboards, and panels. Coordinate with Division 06 Section "Rough Carpentry", to provide blocking as required.
5. Provide filler plates for unused spaces in panelboards.
6. Install panelboards plumb and properly secured. Recessed panels shall be flush with wall finishes.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. 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 infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

- E. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

2.8 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified per Division 26.

- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.
 - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 - 4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

2.9 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 262416

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Toggle switches, dimmer switches.
2. Tamper resistant Single straight-blade receptacles.
3. Tamper resistant Duplex straight-blade receptacles.
4. Tamper resistant Ground-fault protective device receptacles.
5. Locking receptacles.
6. Special-purpose power outlet assemblies.
7. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data to include manufacturer's catalog information showing dimensions, colors and configurations:

1. Toggle switches.
2. Key lock switches.
3. Momentary-contact switches.
4. Dimmer switches.
5. Single straight-blade receptacles
6. Duplex straight-blade receptacles.
7. Receptacles with GFCI device.
8. Locking receptacles (twist-locks).
9. Cord connectors.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Dimmers.
2. Single straight-blade receptacles.
3. Duplex straight-blade receptacles.
4. Receptacles with GFCI device.
5. Locking receptacles.

- B. Sample warranties.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Items: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Extra Keys for Key Lock Switches: 10 of each kind.
 - 2. Cord Connectors: One of each kind.
- B. Special Tools:
 - 1. Proprietary equipment and software required to maintain, repair, adjust, or implement future changes to controlled receptacles.
 - 2. Proprietary equipment required to maintain, repair, adjust, or implement future changes to cord connectors.

PART 2 - PRODUCTS

2.1 SPECIFICATION GRADE COMMERCIAL - SWITCHES, DIMMER SWITCHES

- A. Toggle Switch
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN WMUZ and UL 20.
 - 4. Options:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Configuration:
 - 1) Specification grade commercial, 120-277 V, 20 A (1HP @120V, 2HP @ 208V, 2HP @ 277V), single pole, double pole, three way, four way.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- B. Key lock Switches, Toggle Switch with Forked Key Lock
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN WMUZ and UL 20.
 - 4. Options:
 - a. Device Color: White.

- b. Configuration:
 - 1) 120-277 V, 20 A, single pole, double pole, three way, four way.

- C. Momentary Contact Switch:
 - 1. Hubbell, Model# DSM 30W1, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN WMUZ and UL 20.
 - 4. Options:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Configuration:
 - 1) Low Voltage.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

- D. Dimmer Switch 0-10V, 4 Button Switch, Bi-Level Lighting, & Partition Operation:
 - 1. Hubbell, Model# DSC010W, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN EOYX and UL 1472 dimmer.
 - 4. Options:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Switch Style: Push button.
 - c. Dimming Control Style: Push button (Raise/Lower).
 - d. Low Voltage Combination 4 button switch.
 - e. Pilot light.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

- E. Latching Dimmer Switch:
 - 1. Hubbell, Model# DSL010W, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN EOYX and UL 1472 dimmer.
 - 4. Options:
 - a. Device Color: White in accordance with NEMA WD 1.

- b. Switch Style: Push button.
- c. Dimming Control Style: Push button (Raise/Lower).
- d. Low Voltage latching 3 button switch.
- e. Pilot light.
- 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.2 SINGLE STRAIGHT-BLADE RECEPTACLES

- A. Tamper resistant Single Straight-Blade Receptacle:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 - 4. Options:
 - a. Device Color: Black in accordance with NEMA WD 1.
 - b. Configuration:
 - 1) As required by equipment served.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 DUPLEX STRAIGHT-BLADE RECEPTACLES

- A. Tamper-Resistant Duplex Straight-Blade Receptacle:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 - 4. Options:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Configuration:
 - 1) Commercial Specification Grade NEMA 5-20R.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

- B. Wired Half-Controlled Duplex Straight-Blade Receptacle:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN RTX1 and UL Subject 498B.
 - b. Shall be permanently marked.
 - 4. Options:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Configuration: NEMA 5-20R.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

- C. Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
 - 4. Options:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Configuration: Heavy-duty, NEMA 5-20R.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.4 RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES (TAMPER RESISTANT)

- A. Duplex Straight-Blade Receptacle with GFCI Device:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
 - 4. Options:
 - a. Device Color: White in accordance with NEMA WD 1.

- b. Configuration: NEMA 5-20R.
- 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.5 LOCKING RECEPTACLES

- A. NEMA, Locking Receptacle:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 - 4. Options:
 - a. Device Color: Black with yellow voltage indication on face.
 - b. Configuration: See Drawings.

2.6 CONNECTORS, CORDS, AND PLUGS

- A. Outdoor-Use, Watertight, Sealed Cord Connector:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN AXUT and UL 498.
 - 4. Options:
 - a. Configuration: As required by equipment served.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receptacles:
 - 1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION OF SWITCHES

- A. Comply with manufacturer's instructions.
 - 1. Install switches with OFF position down.

- a. Locate close to door frame on latch side of door, or beyond swing of door where appropriate.
- b. Switches indicated in the same area at the same mounting heights shall be ganged together under a common plate.
2. Do not share neutral conductor on load side of dimmers.
3. Provide matching blank face plate for all unused wall boxes.
4. Install devices and plates vertical and plumb. Boxes shall be flush with finished surface.

B. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

1. Provide matching blank face plate for all unused wall boxes.
2. Install receptacles with grounding pole on top.
3. When GFCI receptacles are called for on the Drawings, each outlet shall be provided with a GFCI device. Using a GFCI receptacle to protect "down-stream" receptacles shall not be permitted.
4. Where devices such as duplex receptacles, telephone/data outlets, and TV outlets are shown adjacent to each other, then group all under a common face plate.
5. Install devices and plates vertical and plumb. Boxes shall be flush with finished surface.

B. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's instructions.

B. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

3.5 INSTALLATION OF CONNECTORS, CORDS, AND PLUGS

A. Comply with manufacturer's instructions.

3.6 FIELD QUALITY CONTROL OF SWITCHES

A. Tests and Inspections:

1. Perform tests and inspections in accordance with manufacturers' instructions.

B. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

- C. Assemble and submit test and inspection reports.

3.7 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

- C. Assemble and submit test and inspection reports.

3.8 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

- C. Assemble and submit test and inspection reports.

3.9 FIELD QUALITY CONTROL OF CONNECTORS, CORDS, AND PLUGS

A. Tests and Inspections:

1. Perform tests and inspections indicated in manufacturer's instructions.

B. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

- C. Assemble and submit test and inspection reports.

3.10 SYSTEM STARTUP FOR SWITCHES

- A. Perform startup service.
 - 1. Complete installation and startup checks for momentary switches, dimmer switches, and fan-speed controller switches in accordance with manufacturer's instructions.

3.11 ADJUSTING

- A. Occupancy Adjustments for Controlled Receptacles: When requested within 12 months from 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.

3.12 PROTECTION

- A. Devices:
 - 1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
 - 2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.
- B. Connectors, Cords, and Plugs:
 - 1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726

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SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Enclosed controllers.
 - c. Enclosed switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 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. Submit in PDF format.
 - 4. Coordination charts and tables and related data.

1.4 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 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 used on the Project. Submit in PDF format.
 - 4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ferraz Shawmut (Gould), Bussman, Eaton, Littelfuse, or approved equal.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 - 1. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
- 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. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 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.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 1. Feeders: Class J, time delay.
 2. Motor Branch Circuits: **Class J**, time delay.
 3. Power Electronics Circuits: **Class J, high speed**.
 4. Other Branch Circuits: **Class J, time delay**.
 5. Control Transformer Circuits: Class CC, time delay, control transformer duty.
 6. Provide open-fuse indicator fuses or fuse covers with open fuse indication where available.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Molded-case switches.
 - 5. Enclosures.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. GFEP: Ground-fault circuit-interrupter for equipment protection.
- B. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 2. Enclosure types and details for types other than UL 50E, Type 1.
 - 3. Current and voltage ratings.
 - 4. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. 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. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.
- C. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSIBLE SWITCHES

- A. Eaton Cutler Hammer, Siemens, General Electric, Square D., or approved equal
- B. Type HD, Heavy Duty:
 1. Single throw.
 2. Poles as indicated on drawings.
 3. 240 or 600 V(ac) as required by the particular circuit
 4. Ampere rating as indicated on drawings.
 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
 6. 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 and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

4. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

- A. Eaton Cutler Hammer, Siemens, General Electric, Square D., or approved equal
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600 V(ac) as indicated on drawings, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, 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 and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Eaton Cutler Hammer, Siemens, General Electric, Square D., or approved equal
- B. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.
- C. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker. Circuit breakers must be 100 percent rated.
- E. MCCBs must be equipped with device for locking in isolated position.
- F. Lugs must be suitable for 75 deg C rated wire.
- G. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal 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.

- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 3. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
 - 4. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 5. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 - 6. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered or remote-mounted and powered type as required for type of switch with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: Enclosure must be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1) unless otherwise noted on drawings.
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
- E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
- F. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

- A. Indoor, Dry and Clean Locations: UL 50E, Type 1.
- B. Outdoor Locations: UL 50E, Type 3R
- C. Other Wet or Damp, Indoor Locations: UL 50E, Type 4.
- D. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:
 - 1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - 2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
 - 3. Comply with mounting and anchoring requirements specified in Division 26.
 - 4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
 - 5. Install fuses in fusible devices.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "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.

3.5 FIELD QUALITY CONTROL

- A. Coordinate "Tests and Inspections" Paragraph below with "Qualifications" and articles in Section 260010 "Supplemental Requirements for Electrical."

- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
 - 2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

- C. Tests and Inspections for Molded-Case Circuit Breakers:

1. Visual and Mechanical Inspection:
 - a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that unit is clean.
 - e. Operate circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with coordination study.
2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 M Ω .
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

- 3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.
 - f. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
 - g. Verify operation of charging mechanism. Investigate units that do not function as designed.
 - 3. Test and adjust controls, remote monitoring, and safeties.
- D. Nonconforming Work:
- 1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- E. Collect, assemble, and submit test and inspection reports.
- 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.
- F. Manufacturer Services:
- 1. Engage factory-authorized service representative to support field tests and inspections.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26.

3.7 PROTECTION

- A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

- A. Infrared Scanning of Enclosed Switches and Breakers: **Two months** after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, **one at four months and another at 11 months after Substantial Completion.**
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262816

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SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting.
 - 2. Exit signs.
 - 3. Materials.
 - 4. Luminaire support components.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. Correlated Color Temperature (CCT): The absolute temperature, measured in kelvins, of a blackbody whose chromaticity most nearly resembles that of the light source.
- B. Color Rendering Index (CRI): Measure of the degree of color shift that objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Lumen (lm): The SI derived unit of luminous flux equal to the luminous flux emitted within a unit solid angle by a unit point source (1 lm = 1 cd-sr).

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - a. Include data on features, accessories, and finishes.
 - b. Include physical description of unit and dimensions.
 - c. Battery and charger for light units.
 - d. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - e. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of luminaire.
- B. Product Test Reports: For each luminaire for tests performed by, or under supervision of, qualified luminaire photometric testing laboratory.
- C. Sample Warranty: For manufacturer's warranty.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
 - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.6 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

- A. Special Installer Extended Warranty for Emergency and Exit Lighting: Installer warrants that fabricated and installed emergency luminaires and exit signs, including batteries, perform in accordance with specified requirements and agrees to repair or replace components and assemblies that fail to perform as specified within extended warranty period.
 - 1. Extended Warranty Period: Two year(s) from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- B. Comply with NFPA 101.
- C. Comply with NEMA LE 4 for recessed luminaires.
- D. Comply with UL 1598 for fluorescent luminaires.

2.2 EMERGENCY LIGHTING

- A. Emergency Lighting Unit:
 - 1. Manufacturers: Lithonia, Lightalarms, Sure-Lite, Chloride, Dual-Lite, Prescolite, or approved equal.
 - 2. Options:
 - a. Wall with universal junction box adaptor.
 - b. UV stable thermoplastic housing.
 - c. Two LED lamp heads.
 - d. Batteries sized to provide minimum 90 minutes of run time.

2.3 EXIT SIGNS

- A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Sign
 - 1. Brushed aluminum housing with universal mounting and red lettering.
 - 2. Manufacturers: Lithonia, Lightalarms, Sure-Lite, Chloride, Dual-Lite, Prescolite, or approved equal.
 - 3. Options:
 - a. Lamps for AC Operation:
 - 1) LEDs; 50,000 hours minimum rated lamp life.
 - b. Self-Powered Exit Signs (Battery Type): Internal emergency power unit. Batteries sized for 90 minutes of run time.

2.4 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 0.106 inch (2.69 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- B. Aim directional lampheads to maximize light in egress paths and as directed.
- C. D.C. Wiring: No.10 AWG. minimum, or as noted, in rigid conduit or electrical metallic tubing or concealed MC cable.
 - 1. Except as noted, use home run from each device to associated battery unit.
 - 2. Devices may share same home run to battery unit provided that each home run meets the following criteria or wire sizes are increased to assure maximum of 2-1/2% voltage drop.

Total Watts	Total Conductor Distance
70	25 ft.
50	35 ft.
36	45 ft.
19	95 ft.

- D. AC Wiring to Exit Lights: In separate conduit, or MC cable with ground.
- E. Exit Sign Mounting: Generally mount directly above and centered over the doorway opening, on the wall where possible, or mounted from the ceiling when wall mounting is not possible. End wall mounted where required, up 7'-6" AFF. The intent is to locate signs to allow for maximum visibility. Consult Architect before installation, if in question.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Nonconforming Work:
 1. Luminaire will be considered defective if it does not pass operation tests and inspections.
 2. Remove and replace defective units and retest.
- C. Prepare test and inspection reports.

3.5 SYSTEM STARTUP

- A. Perform startup service:
 1. Charge batteries minimum of one hour and depress switch to conduct short-duration test.

3.6 PROTECTION

- A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

END OF SECTION 265213

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SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Expanding the existing Addressable fire-alarm system.
- B. Related Requirements:
 - 1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables".
 - 2. Section 260010 – Supplemental Requirements for Electrical.

1.3 DEFINITIONS

- A. DACT: Digital alarm communicator transmitter.
- B. EMT: Electrical metallic tubing.
- C. FACP: Fire-alarm control Panel.
- D. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).
- E. NICET: National Institute for Certification in Engineering Technologies.
- F. PC: Personal computer.
- G. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - 1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
 - 2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.4 ACTION SUBMITTALS

- A. Submittal: Submittals must be reviewed by authorities having jurisdiction prior to submitting them to Architect.

- B. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- C. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, and details, including details of attachments to other Work.
 - 3. Equipment (sensors, modules, etc.)
 - 4. Wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For Installer.
- B. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 - 2. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 3. Keys and Tools: One extra set for access to locked or tamperproofed components.
 - 4. Audible and Visual Notification Appliances: One of each type installed.
 - 5. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
 - 2. Installation must be by personnel certified by NICET as fire-alarm Level III technician.
 - 3. Obtain certification by NRTL in accordance with NFPA 72.
 - 4. Licensed or certified by authorities having jurisdiction.

1.8 FIELD CONDITIONS

- A. Seismic Conditions: Unless otherwise indicated on Contract Documents, specified Work in this Section must withstand the seismic hazard design loads determined in accordance with ASCE/SEI 7 for installed elevation above or below grade.
 - 1. The term "withstand" means "unit must remain in place without separation of parts from unit when subjected to specified seismic design loads and unit must be fully operational after seismic event."

1.9 WARRANTY

- A. Provide Manufacturer's standard warranty.
- B. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ADDRESSABLE FIRE-ALARM SYSTEM

- A. Description:
 - 1. Existing addressable system expanded to meet the requirements of the building alterations and renovations. Notifier AFP-400.

2.2 FIRE-ALARM CONTROL PANEL (FACP)

- A. Notifier.
- B. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.

2.3 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.
 - 2. Station Reset: Key- or wrench-operated switch.

2.4 SYSTEM SMOKE DETECTORS

- A. Photoelectric Smoke Detectors:
 - 1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 268.
 - b. General Characteristics:
 - 1) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.

- 2) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- 3) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- 4) Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
- 5) Operator at FACP, having designated access level, must 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.).
- 6) Detector must have functional humidity range within 10 to 90 percent relative humidity.
- 7) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACP for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACP.
- 8) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACP for 15 or 20 deg F (8 or 11 deg C) per minute.
- 9) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACP to operate at 135 or 155 deg F (57 or 68 deg C).
- 10) Multiple levels of detection sensitivity for each sensor.
- 11) Sensitivity levels based on time of day.

B. Ionization Smoke Detectors:

1. Notifier.
2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 268.
 - b. General Characteristics:
 - 1) Detectors must be two-wire type (addressable).
 - 2) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
 - 3) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 4) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 5) Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
 - 6) Operator at FACP, having designated access level, must 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.).
- 7) Detector must have functional humidity range within 10 to 90 percent relative humidity.
- 8) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACP for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACP.
- 9) Multiple levels of detection sensitivity for each sensor.
- 10) Sensitivity levels based on time of day.

2.5 HEAT DETECTORS

A. Combination-Type Heat Detectors:

- 1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.
 - b. General Characteristics:
 - 1) Temperature sensors must test for and communicate sensitivity range of device.
 - c. Actuated by fixed temperature of 135 deg F (57 deg C) or rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 - d. Mounting: Adapter plate for outlet box mounting or Twist-lock base interchangeable with smoke-detector bases.
 - e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
 - f. Detector must have functional humidity range of 10 to 90 percent relative humidity.

B. Fixed-Temperature-Type Heat Detectors:

- 1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.
 - b. General Characteristics:
 - 1) Actuated by temperature that exceeds fixed temperature of 190 deg F (88 deg C).
 - 2) Mounting: Adapter plate for outlet box mounting or Twist-lock base interchangeable with smoke-detector bases.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
 - 4) Detector must have functional humidity range of 10 to 90 percent.

2.6 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Voice/Tone Notification Appliances:

- 1. Description: Notification appliances capable of outputting voice evacuation messages.
- 2. Performance Criteria:
 - a. Regulatory Requirements:

- 1) NFPA 72.
- 2) UL 1480.
- b. General Characteristics:
 - 1) Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - 2) High-Range Units: Rated 2 to 15 W. (For loud ambient areas)
 - 3) Low-Range Units: Rated 1 to 2 W. (For quiet areas)
 - 4) Matching Transformers: Tap range matched to acoustical environment of speaker location.
 - 5) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Fire-Alarm Visible Notification Appliances:

1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 1971.
 - b. General Characteristics:
 - 1) Clear or nominal white polycarbonate lens mounted on faceplate.
 - 2) Mounting: Wall mounted unless otherwise indicated.
 - 3) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
 - 4) Flashing must be in temporal pattern, synchronized with other units.
 - 5) Strobe Leads: Factory connected to screw terminals.
 - 6) Mounting Faceplate: Factory finished, red.
 - 7) 15/30/75/110 cd Selectable.

2.7 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Performance Criteria:

1. Regulatory Requirements:
 - a. NFPA 72.
2. General Characteristics:
 - a. Include address-setting means on module.
 - b. Store internal identifying code for control panel use to identify module type.
 - c. Listed for controlling HVAC fan motor controllers.
 - d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
 - e. Integral Relay: Capable of providing direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown, for mag. door release etc..
 - 1) Allow control panel to switch relay contacts on command.
 - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
 - f. Control Module:
 - 1) Operate solenoids for use in sprinkler service.

2.8 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Specified in Division 26 Section 260519 "Low-Voltage Electrical Power Conductors and Cables".
- B. Alarm System Wiring Within Building: Minimum size #16 AWG for initiating circuits and #14 AWG for alarm signal circuits, all copper THWN, except as noted. Non power limited wiring and exposed wiring shall be in rigid conduit or electrical metallic tubing or flexible metal conduit in accordance with Specifications for locations used, see Section Wire and Cable: Wiring Methods. Concealed power limited wiring in dry locations above ceilings, in attic space, in stud walls, except as noted, shall be MC Cable fire resistant teflon covered cables approved for use in an air plenum for fire alarm system.
 - 1. Cables shall be properly supported, labeled and tie wrapped.
 - 2. Complete installation shall meet requirements of NEC Article 760 "Fire Protective Signaling Systems."
 - 3. Cables shall be separated from any conductors of power or class 1 circuits and shall not enter in same conduits or J-boxes.
- C. SLC Multiplex Communication Loop: Twisted shielded pair sized per manufacturer and installed in conduit.
- D. Voice Speaker and Telephone Circuits: Twisted shielded pair sized per manufacturer.
- E. All wiring shall be per manufacturers recommendations for load and length required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
- B. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

- A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before other trades have completed cleanup must be replaced.
 - 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
- B. Conform to all requirements of the Authority Having Jurisdiction (AHJ).
- C. All components of the same manufacturer, FM approved and listed by Underwriters' Laboratories, Inc., and so labeled.
- D. Smoke detectors shall not be installed prior to system programming and testing period. If construction is on going during this period, then protect the smoke detectors from contamination and physical damage.
- E. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, duct smoke detectors.
- F. Provide nameplates identifying all equipment, junction boxes and controls. Paint all junction boxes red.
- G. Include all necessary software, programming and the selection of the proper type and quantities of the system components to assure a complete, operational, and Code Compliant System.
- H. Where the effect of more than one strobe is visible in one location (including reflected light), then configure the system to synchronize the strobes.
- I. All panels shall be flush mounted in finished areas and may be surface mounted in unfinished areas such as storage rooms. Where devices are surface mounted, the back box shall be a cast red box designed to mate with the device for a smooth appearance.
- J. System shall be completely field programmable.
- K. The drawings do not show all details of the Fire Alarm System. It shall be the responsibility of the authorized supplier/installer to provide a fully operational code compliant system.
- L. Special Programmable Features:
 - 1. HVAC units: Interface shall be field programmable to allow activation on general alarm and/or on selective zoning of local detectors. Set initially to shut down on general alarm, plus send status signal to the Energy Management/Temperature Control system (ATC) provided under Division 23. For all HVAC equipment that is required to be shut down upon a fire alarm condition, ensure that fire alarm shutdown of equipment is wired through input contacts within the VFD/starter enclosure. Upon receipt of a signal from the building's fire alarm system, power to the load side of the VFD/starter shall be turned off. Circuitry shall be provided to ensure that power is off whether the VFD/starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the

- VFD/starter manufacturer, Division 23 shall be responsible for providing a contactor on the line side of the VFD/starter to accomplish the same function. The contactor shall meet the requirements specified under this division.
2. HVAC Duct Smoke Dampers: Interface shall be field programmable to allow activation on general alarm and/or on selective zoning of local detectors. Set initially to close dampers on general alarm, plus send status signal to the Energy Management/Temperature Control system (ATC) provided under Division 23.
 3. Smoke doors: Interface shall be field programmable to allow activation on general alarm and/or on selective zoning of local detectors. Set initially as general alarm with output interface relay connected to close the doors.
 4. Comply with requirements for seismic-restraint devices specified.
- M. Install wall-mounted equipment, with tops of cabinets not more than 78 inch (1980 mm) above finished floor.
1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."
- N. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in normal path of egress within 60 inch (1520 mm) of exit doorway.
 2. Mount manual fire-alarm box on background of contrasting color.
 3. Operable part of manual fire-alarm box must be between 42 and 48 inch (1060 and 1220 mm) above floor level. Devices must be mounted at same height unless otherwise indicated.
- O. Smoke- and Heat-Detector Spacing:
1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing must not exceed 30 ft. (9 m).
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inch (910 mm) from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inch (300 mm) from lighting fixture and not directly above pendant mounted or indirect lighting.
- P. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
- Q. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- R. Device Location-Indicating Lights: Locate in public space near device they monitor.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Division 26.
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

- A. Pathways shall be installed in EMT.
- B. Exposed EMT must be painted red enamel.

3.7 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements. Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch (910 mm) from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.

3.8 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification.
- B. At FACP provide minimum of two ground rods with a “box connecting rod” or a #12 AWG solid copper wire, enclosed in conduit, connect to ground terminal of the FACP. Resistance of ground connection shall not exceed 25 ohms.
- C. Install framed instructions in location visible from FACP.

3.9 GROUNDING

- A. Ground FACP and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

- A. Field tests may be witnessed by Owner, Contractor, and authorities having jurisdiction (Local Fire Chief). Invite Architect/Engineer’s representative.
- B. Administrant for Tests and Inspections:
 - 1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Include testing at substantial completion, at 6 months after occupancy and again two weeks prior to end of first year warranty. (Total of 3 complete documented tests). Invite the Owner, Architect and Local Fire Department to witness each test.
 - 2. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
 - 3. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
- D. Test shall include but not be limited to:
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Open initiating device circuits and verify that the trouble signal actuates.
 - 3. Open signaling line circuits and verify that the trouble signal actuates.
 - 4. Open and short notification appliance circuits and verify that trouble signal actuates.

5. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.
 6. Ground initiating device circuits and verify response of trouble signals.
 7. Ground signaling line circuits and verify response of trouble signals.
 8. Ground notification appliance circuits and verify response of trouble signals.
 9. Check installation, supervision, and operation of all intelligent smoke detectors using walk test.
 10. Each of the alarm conditions that the system is required to detect shall be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control panel points.
 11. When the Vendor determines that the system must be equipped with optional features to satisfy this specification, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.
 12. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
 13. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
 14. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
 15. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner.
- B. In addition to the site training on programming features previously specified, provide minimum of two four hour periods to instruct the owner in the proper operation and maintenance requirements of the system. Provide one four hour period at substantial completion (after all testing and the system is fully operational and accepted by the fire department) and the other four hour period six months after substantial completion.
- C. Provide a typewritten, bound, laminated "Sequence of Operation" to the Owner.

END OF SECTION 284621.11

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