City of Milwaukee

# Department of Public Works

# Infrastructure Services Division Facilities Development & Management Section

## Police Administration Building
## New Chase and High Rise Upgrades

749 West State Street
Milwaukee, Wisconsin

April 2012

Project Number PL 1208 0726
Official Notice No. 73

CITY OF MILWAUKEE, WISCONSIN

DEPARTMENT OF PUBLIC WORKS

INFRASTRUCTURE SERVICES DIVISION

FACILITIES DEVELOPMENT &
MANAGEMENT SECTION

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# PROJECT MANUAL

GOVERNING THE

# POLICE ADMINISTRATION BUILDING
# NEW CHASE AND HIGH RISE UPGRADES

749 WEST STATE STREET
MILWAUKEE, WISCONSIN

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Project No. PL 1208 0726

April, 2012

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# CITY OF MILWAUKEE
# GENERAL OFFICIAL NOTICE
# TO CONTRACTORS

Separate sealed bids for each project will be received until 10:30 A.M. of the bid opening date at which time bids will be publicly opened and read for furnishing all material and doing all work for each project in accordance with the requirements of the respective Official Notice on the bid form furnished in accordance with plans, specifications, contract documents, and proposed form of contract on file in the office of the Department of Public Works, Municipal Building, 841 N. Broadway, Room 506, Milwaukee, Wisconsin, 53202.

PROSPECTIVE BIDDERS ARE TO CAREFULLY EXAMINE AND REVIEW ALL CONTRACT DOCUMENTS AND MATERIALS IN SAID OFFICE BEFORE SUBMITTING BID.

AFFIDAVITS OF NO INTEREST MUST ACCOMPANY THE BIDS, AND THE FAILURE OF PROSPECTIVE BIDDERS TO COMPLY WITH THESE REQUIREMENTS MAY DISQUALIFY THE BID.

THE CONTRACTOR/LESSEE AGREES TO COMPLY WITH ALL APPLICABLE REQUIREMENTS OF THE AMERICANS WITH DISABILITIES ACT OF 1990, 42 U.S.C. § 12101, ET. SEQ. THE TDD NUMBER FOR PUBLIC WORKS IS (414) 286-2025.

As part of the bid each bidder shall submit a list of anticipated subcontractors and the class of work to be performed by each, which list should not be added to nor altered without the written consent of the Commissioner of Public Works.

All contractor(s) and subcontractor(s) are required to furnish or have on file a certificate of insurance in accordance with the insurance provisions of the General Specifications.

All contractor(s) and subcontractor(s) are subject to the prevailing wage rates and hours of labor as prescribed by the Common Council of the City of Milwaukee consistent with provisions of Section 66.0903 of the Wisconsin Statutes.

Copies of the actual work classifications and wage and fringe benefit rates enforced on this project are available in Room 506 of the Municipal Building.

Corporate surety will be required on performance and payment bonds for all projects listed in the following Official Notices. All applicable charter and Statutory provisions and ordinances, all the provisions of this official notice, invitation to bid, general and detailed specifications, special provisions, proposal, schedule of fixed prices, addendum and plans for this project and all other contract documents set forth in the invitation to bid will be incorporated and made part of the contract as if therein set forth in full.

Tie bids, when the lowest ones, will be decided by the Commissioner of Public Works.

The Commissioner of Public Works reserves the right to reject any or all bids.

Signed: GHASSAN KORBAN,
Commissioner of Public Works

Countersigned: W. MARTIN MORICS,
City Comptroller

# CITY OF MILWAUKEE
# SPECIFIC OFFICIAL NOTICE NO. 73

Important Notice:

The Invitation to Bid, all bid documents and the Plans & Specifications for the project listed will be available electronically to prospective bidders via http://www.mpw.net/bids/docs/73-2012. Any required addenda or responses related to the listed projects will be posted on said website. Bidders are encouraged to utilize this electronic method of obtaining bid documents as the Department of Public Works intends to solely use this method for future projects. At this time however, a limited number of hard copies of the above documents will also be available at address listed below. **IF YOU ONLY PRINT THE DOCUMENTS FROM THE WEBSITE AND WOULD LIKE YOUR COMPANY'S NAME PLACED ON THE PLAN HOLDERS' LIST, PLEASE CALL 414-286-3314.**

Sealed bids will be opened on Thursday, May 17, 2012 at 10:30 A.M. for the **NEW CHASE AND HIGH RISE UPGRADES**, located at Police Administration Building, 749 W. State Street, Milwaukee, WI.

Bid Security Required: Bond, Certified Check, Cashier's Check, or Cash to accompany bid: 10% of Contractor's Base Bid

Time for Completion: 220 Working Days.
Contractor shall not begin work on this project prior to Monday, May 28, 2012.

Liquidated Damages, per diem: $1080.00

The MWSBE requirement for this project is 25% of the contract base bid.

**(African American: 5.57%, Asian American: 0%, WBE: 4%, SBE: 15.43%)**

For a complete listing of City of Milwaukee certified M/W/SBE firms, see the Office of Small Business Development's (OSBD) website at http://city.Milwaukee.gov/osbd. If there are any questions regarding M/W/SBE certified firms, please contact OSBD office at (414) 286-5553.

The apprenticeship requirements for this project are: **4**

Apprentice(s) from **4** of the following trade(s) are to be employed:

**Carpenter, Drywaller, Insulator, Iron Worker, Electrician, Painter, Plumber, Sheet Metal Worker**

The contractor shall specifically note the MWSBE, residency, and apprenticeship forms for this project. If the forms are not filled out properly, it will be cause for rejection of the bid.

Plans and project manual will be furnished to the prospective bidders upon payment of a $10.00 non-refundable fee in room 506, Frank P. Zeidler Municipal Building, 841 North Broadway, Milwaukee, Wisconsin 53202. For general questions call 414-286-3314.

A $10.00 per set additional non-refundable fee is required to obtain bid documents by mail. Plans are sent via U.S. mail unless other arrangements are made by the contractor.

Contractor must comply with all provisions of the CITY OF MILWAUKEE GENERAL OFFICIAL NOTICE TO CONTRACTORS published herein and at http://mpw.milwaukee.gov/services/bids_home

Pre-Bid Meeting: A Pre-Bid Meeting is scheduled for Friday, May 04, 2012, at 2:00 p.m. in Room 606 of the Frank P. Zeidler Municipal Building, 841 North Broadway, Milwaukee, Wisconsin. Bidder participation is urged to become familiar with all aspects of the project and bidding requirements.

Signed:

_____
GHASSAN KORBAN
Commissioner of Public Works

PUBLISH SIX (6) TIMES INSERTION WITHOUT FAIL, Thursday, April 26, 2012

SECTION 00100: INSTRUCTIONS TO BIDDERS

See also Instructions to Bidders in the "General Specifications" of the Department of Public Works, City of Milwaukee, Wisconsin, dated January 31, 1992, and all subsequent addenda.

BID FORM:

Submit a lump sum price for the work as indicated on the drawings and specified herein, complete in every respect.

Bids will not be accepted in any form except on the bid form included with this project manual.

The contractor must recognize and abide by the right of the Owner (City of Milwaukee) to accept or reject any or all bids in the best interests of the City.

ALTERNATE:

Each bidder shall examine the plans and project manual thoroughly to determine what extent the Alternate will affect the bid.

Alternate Deduct No.1:

State the amount to be **deducted from** the Base Bid to perform all work and furnish all materials for new fire pump, jockey pump and controllers located in dedicated room to replace existing fire pump as shown on drawings and indicated in Project Manual.

Alternate Deduct No. 2:

State the amount to be **deducted from** the Base Bid to perform all work and furnish all materials for new pressurization fans and controls for stair towers and elevator hoist ways as shown on drawings and indicated in Project Manual.

Informational Price:

The requested prices are for informational purposes to be considered after contract award and would be used at the City's discretion to adjust work as a change to the contract. Price is to include all coordination, modification or adjustment to adjacent work, miscellaneous devices and accessory objects as required to completely integrate the work of this change into Project. These prices will not be used in the awarding of the bid.

Informational Price 1:

State the adjustment amount (deducted or added) to the Base Bid to perform all work and furnish all materials to provide Glass Fiber Reinforced Concrete “GFRC” Wall Panels in accordance with the requirements of section 3 “GFRC” in lieu of “Precast Concrete Wall Panels”.

Informational Price 2:

State the amount (deducted or added) to the Base Bid to construct the east and west Mechanical Shafts in sequence and not concurrently as included in base bid. This Informational Price is to include (but not limited to) all costs impacts to associated staging, demolition, temporary enclosure and new construction costs, in lieu of constructing the shafts in concurrently .

CONTRACT AWARD:

The Commissioner of Public Works will award the contract on the basis of the Base Bid only or the Base Bid and the Deduct Alternate as funds permit.

CONTRACT BREAKDOWN:

Shortly after the award of the contract, each contractor shall submit a list showing the cost breakdown of the items in his contract. This list will be used as a basis for estimates of work completed for partial payment.

SITE VISIT:

All contractors shall visit the site, consult the drawings and project manual, be familiar with the work of other contractors and determine for himself all conditions affecting the work. **Contractors must schedule site visits with Project Contact.** Access to site (specifically building interior) is limited and by appointment only, unscheduled tours of building will not be allowed.

Failure by a contractor to be familiar with the project shall not release him from any obligation under this contract to complete the work in strict conformity with the plans and project manual and all City, State and Federal Codes or regulations pertaining to the work.

CONSTRUCTION START AND COMPLETION DATES

The start and completion dates are stated in the Specific Official Notice. The contractor may begin procuring materials and off-site fabricating (as appropriate and approved by Architect) on the date on the Notice to Proceed. The Notice to Proceed will be sent to the contractor directly following the signing of the contract.

BASE BID EXCLUSIONS:

Removal of hazardous (Asbestos) materials is outside this contract and is to be performed by Others.

ADDITIONAL PLANS/PROJECT MANUALS

The successful contractor will be responsible for furnishing all additional copies of plans, project manuals, addenda, etc., as may be needed by the contractor and subcontractors. The City will cooperate by making originals available to the contractor's printer of choice.

SECTION 00700: GENERAL CONDITIONS

1. SCOPE:

A. Index:

1. Scope
2. DPW General Specifications
3. Definitions
4. Control of Work and Materials
5. Samples and Tests
6. Project Coordination
7. Supervision of Work
8. Technical Specifications and Drawings
9. Safety Regulations
10. Code Rules

2. Department of Public Works General Specifications:

Provisions of the Department of Public Works General Specifications dated January 31, 1992, and subsequent addenda except as may be modified or expanded upon in this project manual, shall apply to all contractors and subcontractors working on the project. Copies of the General Specifications may be obtained from the Department of Public Works General Office, Room 501 Zeidler Municipal Building, 841 North Broadway, Milwaukee, Wisconsin, or from the Buildings & Fleet Services, Room 602, Zeidler Municipal Building.

3. Definitions:

A. Owner: City of Milwaukee.

B. Facilities Manager: The Facilities Manager of Buildings and Fleet Services.

C. Project Inspector: The authorized representative of the Commissioner assigned to make detailed inspection of any or all portions of the work and materials thereof. These inspections are not a substitute to those required by the Department of Neighborhood Services for permit and code compliance.

D. Addenda: Written or graphic instruments issued prior to the execution of the contract which modify or interpret the bidding documents, including drawings and project manual by additions, deletions, clarifications or corrections. Addenda will become part of the contract documents when the contract is executed.

E. Contract Drawings: Drawings of the work to be done as listed hereafter in Section 00850 Drawing Schedule.

4. Control of Work and Materials:

A. Detail and Shop Drawings: Shop drawings and other additional drawings which may be required for each contract of the work shall be prepared by each respective contractor unless otherwise directed by the Facilities Manager. Prints shall be the same size as contract documents when practical. Prints of each drawing shall be submitted to the Facilities Manager for approval before proceeding with the work. Changes ordered by the Facilities Manager shall be made and revised prints submitted as above. The Facilities Manager's approval of drawings

shall not relieve the contractor of responsibility for errors.

B. Primary Lines and Grades: The City of Milwaukee will mark two building corners along a line and will establish a benchmark, with a relative elevation, within close proximity to the site. Once established by the City, the contractor shall preserve all points and benchmark as long as needed during construction. The contractor will bear all costs associated with re-establishing points and benchmark.

C. Construction Lines and Grades: The contractor must bear sole responsibility for the correct transferal of all construction lines and grades from the primary lines and grades points. He shall take such measurements from existing work as may be necessary to insure the proper construction of his work.

D. Material Orders and Shipping Statements: The contractor shall furnish to the Facilities Manager at least two (2) copies of all material orders and shipping statements. Itemized weights of the materials and individual units of finished work shall be shown.

E. Weighing of Materials and Fabricated Units: The weighing of materials and fabricated units such as structural steel, casings, etc., when required, shall be done in the presence of the Commissioner's representative. The contractor shall be responsible for the satisfactory weighing of such materials and units.

F. Consignment and Delivery of Materials: The materials for the work shall be consigned to the contractor and he shall be responsible for the delivery of all materials required for the completion of the contract.

5. Samples and Tests:

A. Method of Sampling: Samples of the materials proposed or furnished for the work may be taken by the Commissioner at any time; at the point of manufacture, point of delivery or site of work. They will be selected, as far as practicable, in accordance with standard methods of sampling such materials as specified in the standard of the American Society for Testing Material. All sampling shall be done by authorized representatives of the Commissioner. Selections will be in an orderly and systematic manner, insuring samples representative of the lot.

B. A.S.T.M. Standards: Wherever the abbreviation A.S.T.M. is used in connection with the number of a standard specification, the specification referred to shall be the Standard of the American Society for Testing Materials, designated by that number, including all revisions in effect on the date of award of the contract. Should a revised or amended standard be issued by the American Society for Testing Materials which, in the opinion of the Commissioner, conflicts with or causes undesirable changes in the standards referred to herein, the Commissioner reserves the right, by means of addenda to the project manual, to continue under the provisions of the pertinent standard referred to herein.

C. Cost of Test Specimens and Samples: All test specimens of metals and all samples of non-metals required for tests shall be furnished by the contractor without cost to the City.

D. Costs of Tests: All tests on test specimens of metals will be made at the expense of the contractor and the original test on samples of non-metals will be made at the expense of the City. In all cases, the testing procedure will be in accordance with Standard A.S.T.M. tests for such materials. Subsequent tests of non-metals requested by the contractor, when such tests are permitted by A.S.T.M. Specifications and approved by the Commissioner or subsequent tests ordered by the Commissioner will be made at the expense of the contractor.

6. Project Coordination:

A. Contractors are required, so far as possible, to arrange work and to dispose of materials so as not to interfere with the work or storage of materials of other contractors or City forces engaged upon the work.

B. Contractors shall give full cooperation to other trades and furnish any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

C. Where the work of a contractor will be installed in close proximity to the work of other trades, or where there is evidence that the work of a contractor will interfere with the work of other trades, he shall assist in working out space conditions to make satisfactory adjustments.

D. If a contractor installs work before coordinating it with other trades or so as to cause interference with work of other trades, he shall make necessary changes in his work to correct the condition without extra charge.

E. Contractors are required to join their work to that of others in a proper manner, and in accordance with the spirit of the plans and project manual, and to perform the work in the proper sequence in relation to that of other contractors, and as may be directed by the Project Inspector.

7. Supervision of Work:

A. Contractors shall furnish the services of an experienced engineer or superintendent.

B. He shall be constantly in charge of the installation of the work together with all subcontractors, skilled workers, helpers, and labor required to unload, transfer, erect, connect up, adjust, start, operate and test each system.

C. He shall be thoroughly acquainted with and be responsible for the various subcontractors' work so that it is properly coordinated and supervised to the satisfaction of the Commissioner of Public Works or his representative.

D. Upon written notice to a contractor of the lack of such coordination and supervision, the Commissioner of Public Works may authorize such services as may be required and deduct the cost of this service at an hourly rate of $60.00 per hour per worker from the contract for the work.

8. Technical Specifications and Drawings:

A. Governing order of Contract Documents:

1. The following provision modifies DPW General Specifications Item 2.1.3.1:

Anything mentioned in the Technical Specifications and not shown on the drawings or shown on the drawings and not mentioned in the Technical Specifications, shall be as if shown on or mentioned in both. In case of difference between drawings and Technical Specifications, the Technical Specifications shall govern. In case of any discrepancy in drawings or Technical Specifications, the matter shall be immediately submitted to Buildings & Fleet Services for decision. Said discrepancy shall not be adjusted by the contractor.

B. All contractors shall have complete sets of plans and project manuals on the job site at all times.

9. Safety Regulations:

All work shall be done in accordance with the safety requirements referenced in the International Building Code, as adopted and amended by the State of Wisconsin and OSHA.

10. Code Rules:

The rulings, regulations and laws of the following shall be complied with in the completion of this project:

International Building Code, as amended and adopted by the State of Wisconsin
Plumbing and Drainage Codes of the City of Milwaukee
Ordinances of the City of Milwaukee
National Board of Fire Underwriters
OSHA
NFPA
FAA
NEC
IEEE
UL

SECTION 00821: INSPECTION CHARGES

The contractor will be charged a fee for inspection for each and every day such inspection is required after the time allowed for completion has expired.

The amount of the fee for inspection shall be $325.00 per day.
*Rev. 2/08*

The time allowed for completion is stated in the Specific Official Notice and shall start with the date on the Notice to Proceed which will be sent to the contractor directly following the signing of the contract. The time allowed includes the time required for fabricating and procuring material and doing the work at the building site.

**PREVAILING WAGE RATE DETERMINATION**
Issued by the State of Wisconsin
Department of Workforce Development
Pursuant to s. 66.0903, Wis. Stats.
Issued On: 01/13/2012
Amended On: 03/02/2012

| | |
|---|---|
| **DETERMINATION NUMBER:** | 201200107 |
| **EXPIRATION DATE:** | Prime Contracts MUST Be Awarded or Negotiated On Or Before 12/31/2012. If NOT, You MUST Reapply. |
| **PROJECT NAME:** | ALL PUBLIC WORKS PROJECTS UNDER SEC. 66.0903, STATS.-CITY OF MILWAUKEE |
| **PROJECT LOCATION:** | MILWAUKEE CITY, MILWAUKEE COUNTY, WI |
| **CONTRACTING AGENCY:** | CITY OF MILWAUKEE-DEPT OF PUBLIC WORKS |

| | |
|---|---|
| **CLASSIFICATION:** | Contractors are responsible for correctly classifying their workers. Either call the Department of Workforce Development (DWD) with trade or classification questions or consult DWD's Dictionary of Occupational Classifications & Work Descriptions on the DWD website at: dwd.wisconsin.gov/er/prevailing_wage_rate/Dictionary/dictionary_main.htm. |
| **OVERTIME:** | Time and one-half must be paid for all hours worked:<br>- over 10 hours per day on prevailing wage projects<br>- over 40 hours per calendar week<br>- Saturday and Sunday<br>- on all of the following holidays: January 1; the last Monday in May; July 4; the 1st Monday in September; the 4th Thursday in November; December 25;<br>- The day before if January 1, July 4 or December 25 falls on a Saturday;<br>- The day following if January 1, July 4 or December 25 falls on a Sunday.<br>Apply the time and one-half overtime calculation to whichever is higher between the Hourly Basic Rate listed on this project determination or the employee's regular hourly rate of pay. Add any applicable Premium or DOT Premium to the Hourly Basic Rate before calculating overtime.<br><br>A DOT Premium (discussed below) may supersede this time and one-half requirement. |
| **FUTURE INCREASE:** | When a specific trade or occupation requires a future increase, you MUST add the full hourly increase to the "TOTAL" on the effective date(s) indicated for the specific trade or occupation. |
| **PREMIUM PAY:** | If indicated for a specific trade or occupation, the full amount of such pay MUST be added to the "HOURLY BASIC RATE OF PAY" indicated for such trade or occupation, whevenever such pay is applicable. |
| **DOT PREMIUM:** | This premium only applies to highway and bridge projects owned by the Wisconsin Department of Transportation and to the project type heading "Airport Pavement or State Highway Construction." DO NOT apply the premium calculation under any other project type on this determination. |
| **APPRENTICES:** | Pay apprentices a percentage of the applicable journeyperson's hourly basic rate of pay and hourly fringe benefit contributions specified in this determination. Obtain the appropriate percentage from each apprentice's contract or indenture. |
| **SUBJOURNEY:** | Subjourney wage rates may be available for some of the trades or occupations indicated below with the exception of laborers, truck drivers and heavy equipment operators. Any employer interested in using a subjourney classification on this project MUST complete Form ERD-10880 and request the applicable wage rate from the Department of Workforce Development PRIOR to using the subjourney worker on this project. |

This document **MUST BE POSTED** by the **CONTRACTING AGENCY** in at least one conspicuous and easily accessible place **on the site of the project** . A local governmental unit may post this document at the place normally used to post public notices if there is no common site on the project. This document **MUST** remain posted during the entire time any worker is employed on the project and **MUST** be physically incorporated into the specifications and all contracts and subcontracts. If you have any questions, please write to the Equal Rights Division, Labor Standards Bureau, P.O. Box 8928, Madison, Wisconsin 53708 or call (608) 266-6861.

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**The following statutory provisions apply to local governmental unit projects of public works and are set forth below pursuant to the requirements of s. 66.0903(8), Stats.**

**s. 66.0903 (1) (f) & s. 103.49 (1) (c) "PREVAILING HOURS OF LABOR"** for any trade or occupation in any area means 10 hours per day and 40 hours per week and may not include any hours worked on a Saturday or Sunday or on any of the following holidays:

1. January 1.
2. The last Monday in May.
3. July 4.
4. The first Monday in September.
5. The 4th Thursday in November.
6. December 25.
7. The day before if January 1, July 4 or December 25 falls on a Saturday.
8. The day following if January 1, July 4 or December 25 falls on a Sunday.

**s. 66.0903 (10) RECORDS; INSPECTION; ENFORCEMENT.**
(a) Each contractor, subcontractor, or contractor's or subcontractor's agent performing work on a project of public works that is subject to this section shall keep full and accurate records clearly indicating the name and trade or occupation of every person performing the work described in sub. (4) and an accurate record of the number of hours worked by each of those persons and the actual wages paid for the hours worked.

**s. 66.0903 (11) LIABILITY AND PENALTIES.**
(a) 1. Any contractor, subcontractor, or contractor's or subcontractor's agent who fails to pay the prevailing wage rate determined by the department under sub. (3) or who pays less than 1.5 times the hourly basic rate of pay for all hours worked in excess of the prevailing hours of labor is liable to any affected employee in the amount of his or her unpaid wages or his or her unpaid overtime compensation and in an additional amount as liquidated damages as provided under subd. 2., 3., whichever is applicable.
2. If the department determines upon inspection under sub. (10) (b) or (c) that a contractor, subcontractor, or contractor's or subcontractor's agent has failed to pay the prevailing wage rate determined by the department under sub. (3) or has paid less than 1.5 times the hourly basic rate of pay for all hours worked in excess of the prevailing hours of labor, the department shall order the contractor to pay to any affected employee the amount of his or her unpaid wages or his or her unpaid overtime compensation and an additional amount equal to 100 percent of the amount of those unpaid wages or that unpaid overtime compensation as liquidated damages within a period specified by the department in the order.
3. In addition to or in lieu of recovering the liability specified in subd. 1. as provided in subd. 2., any employee for and in behalf of that employee and other employees similarly situated may commence an action to recover that liability in any court of competent jurisdiction. If the court finds that a contractor, subcontractor, or contractor's or subcontractor's agent has failed to pay the prevailing wage rate determined by the department under sub. (3) or has paid less than 1.5 times the hourly basic rate of pay for all hours worked in excess of the prevailing hours of labor, the court shall order the contractor, subcontractor, or agent to pay to any affected employee the amount of his or her unpaid wages or his or her unpaid overtime compensation and an additional amount equal to 100 percent of the amount of those unpaid wages or that unpaid overtime compensation as liquidated damages.
5. No employee may be a party plaintiff to an action under subd. 3. unless the employee consents in writing to become a party and the consent is filed in the court in which the action is brought. Notwithstanding s. 814.04 (1), the court shall, in addition to any judgment awarded to the plaintiff, allow reasonable attorney fees and costs to be paid by the defendant.

## BUILDING OR HEAVY CONSTRUCTION

**Includes sheltered enclosures with walk-in access for the purpose of housing persons, employees, machinery, equipment or supplies and non-sheltered work such as canals, dams, dikes, reservoirs, storage tanks, etc. A sheltered enclosure need not be "habitable" in order to be considered a building. The installation of machinery and/or equipment, both above and below grade level, does not change a project's character as a building. On-site grading, utility work and landscaping are included within this definition. Residential buildings of four (4) stories or less, agricultural buildings, parking lots and driveways are NOT included within this definition.**

### SKILLED TRADES

**Fringe Benefits Must Be Paid On All Hours Worked**

| CODE | TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 101 | Acoustic Ceiling Tile Installer | 33.43 | 19.31 | 52.74 |
| 102 | Boilermaker | 31.09 | 21.87 | 52.96 |
| 103 | Bricklayer, Blocklayer or Stonemason<br>Future Increase(s):<br>Add $.50 on 6/01/2012; Add $1.45/hr on 6/01/2013<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year’s Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 35.58 | 16.37 | 51.95 |
| 104 | Cabinet Installer | 29.06 | 15.16 | 44.22 |
| 105 | Carpenter<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 33.43 | 19.31 | 52.74 |
| 106 | Carpet Layer or Soft Floor Coverer | 31.68 | 18.55 | 50.23 |
| 107 | Cement Finisher | 30.87 | 16.33 | 47.20 |
| 108 | Drywall Taper or Finisher<br>Future Increase(s):<br>Add $2.20/hr on 6/1/2012 | 28.97 | 17.74 | 46.71 |
| 109 | Electrician<br>Future Increase(s):<br>Add $1.40/hr on 6/1/2012. Add $1.60/hr on 6/1/2013.<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year’s Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 31.54 | 20.95 | 52.49 |
| 110 | Elevator Constructor | 43.79 | 25.48 | 69.27 |
| 111 | Fence Erector | 27.00 | 0.00 | 27.00 |
| 112 | Fire Sprinkler Fitter | 36.82 | 19.03 | 55.85 |
| 113 | Glazier | 32.25 | 16.20 | 48.45 |
| 114 | Heat or Frost Insulator | 33.28 | 22.45 | 55.73 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 115 | Insulator (Batt or Blown) | 23.62 | 11.55 | 35.17 |
| 116 | Ironworker | 31.31 | 21.54 | 52.85 |
| 117 | Lather | 31.68 | 18.41 | 50.09 |
| 118 | Line Constructor (Electrical) | 35.97 | 18.08 | 54.05 |
| 119 | Marble Finisher | 31.16 | 16.27 | 47.43 |
| 120 | Marble Mason | 35.53 | 15.92 | 51.45 |
| 121 | Metal Building Erector | 21.05 | 7.82 | 28.87 |
| 122 | Millwright | 28.30 | 23.29 | 51.59 |
| 123 | Overhead Door Installer | 26.53 | 0.00 | 26.53 |
| 124 | Painter<br>Future Increase(s):<br>Add $2.20/hr on 6/1/2012.<br>Premium Increase(s):<br>Add $.20/hr for paperhanging; Add $.35/hr for bridge, iron and drywall; Add $.75/hr for spraying and sandblasting; Add $.60/hr for EIFS work; Add $1.00/hr for lead based paint removal. | 28.97 | 17.74 | 46.71 |
| 125 | Pavement Marking Operator | 26.00 | 0.00 | 26.00 |
| 126 | Piledriver | 28.11 | 23.94 | 52.05 |
| 127 | Pipeline Fuser or Welder (Gas or Utility) | 30.52 | 18.84 | 49.36 |
| 129 | Plasterer | 20.13 | 1.03 | 21.16 |
| 130 | Plumber | 36.97 | 17.47 | 54.44 |
| 132 | Refrigeration Mechanic | 37.21 | 19.04 | 56.25 |
| 133 | Roofer or Waterproofer<br>Future Increase(s):<br>Add $.50/hr. effective 06/01/2012 | 29.40 | 15.05 | 44.45 |
| 134 | Sheet Metal Worker | 37.20 | 16.37 | 53.57 |
| 135 | Steamfitter | 38.26 | 19.49 | 57.75 |
| 137 | Teledata Technician or Installer<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 24.65 | 15.67 | 40.32 |
| 138 | Temperature Control Installer | 29.63 | 19.17 | 48.80 |
| 139 | Terrazzo Finisher | 18.00 | 5.35 | 23.35 |
| 140 | Terrazzo Mechanic | 31.16 | 16.27 | 47.43 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 141 | Tile Finisher | 23.76 | 16.05 | 39.81 |
| 142 | Tile Setter | 29.95 | 15.64 | 45.59 |
| 143 | Tuckpointer, Caulker or Cleaner<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 34.35 | 15.92 | 50.27 |
| 144 | Underwater Diver (Except on Great Lakes) | 36.20 | 18.81 | 55.01 |
| 146 | Well Driller or Pump Installer | 25.32 | 15.30 | 40.62 |
| 147 | Siding Installer | 36.60 | 16.37 | 52.97 |
| 150 | Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY | 27.42 | 15.10 | 42.52 |
| 151 | Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY | 28.78 | 15.16 | 43.94 |
| 152 | Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY | 17.80 | 9.00 | 26.80 |
| 153 | Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY | 23.38 | 12.48 | 35.86 |
| 154 | Groundman - ELECTRICAL LINE CONSTRUCTION ONLY | 21.30 | 10.97 | 32.27 |

**TRUCK DRIVERS**

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 201 | Single Axle or Two Axle | 32.32 | 16.75 | 49.07 |
| 203 | Three or More Axle<br>Future Increase(s):<br>Add $1.75/hr on 6/1/2012; Add $1.85/hr on 6/1/2013.<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 22.50 | 16.19 | 38.69 |
| 204 | Articulated, Euclid, Dumptor, Off Road Material Hauler | 33.32 | 17.60 | 50.92 |
| 205 | Pavement Marking Vehicle | 19.25 | 10.84 | 30.09 |
| 207 | Truck Mechanic | 24.91 | 15.35 | 40.26 |

## LABORERS

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 301 | General Laborer<br>Premium Increase(s):<br>Add $.11 for mortar mixer, fork lift operator, air and electric equipment and power buggy operators; Add $.22 for jackhammer operator, certified welder, gunite machineman. | 28.82 | 15.61 | 44.43 |
| 302 | Asbestos Abatement Worker | 21.58 | 17.83 | 39.41 |
| 303 | Landscaper | 12.50 | 2.20 | 14.70 |
| 310 | Gas or Utility Pipeline Laborer (Other Than Sewer and Water) | 19.14 | 15.53 | 34.67 |
| 311 | Fiber Optic Laborer (Outside, Other Than Concrete Encased)<br>Premium Increase(s):<br>DOT PREMIUMS: Pay two times the hourly basic rate on New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 17.24 | 15.00 | 32.24 |
| 314 | Railroad Track Laborer | 17.00 | 1.06 | 18.06 |

## HEAVY EQUIPMENT OPERATORS
## SITE PREPARATION, UTILITY OR LANDSCAPING WORK ONLY

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 501 | Air Track, Rotary or Percussion Drilling Machine &/or Hammers, Blaster; Asphalt Milling Machine; Boring Machine (Directional, Horizontal or Vertical); Backhoe (Track Type) Having a Mfgr's Rated Capacity of 130,000 Lbs. or Over; Backhoe (Track Type) Having a Mfgr's Rated Capacity of Under 130,000 Lbs., Backhoe (Mini, 15,000 Lbs. & Under); Bulldozer or Endloader (Over 40 hp); Compactor (Self-Propelled 85 Ft Total Drum Width & Over, or Tractor Mounted, Towed & Light Equipment); Concrete Batch Plant, Batch Hopper; Concrete Breaker (Large, Auto, Vibratory/Sonic, Manual or Remote); Crane, Shovel, Dragline, Clamshells; Forklift (Machinery Moving or Steel Erection, 25 Ft & Over); Gradall (Cruz-Aire Type); Grader or Motor Patrol; Master Mechanic; Mechanic or Welder; Robotic Tool Carrier (With or Without Attachments); Scraper (Self Propelled or Tractor Drawn) 5 cu yds or More Capacity; Tractor or Truck Mounted Hydraulic Backhoe; Tractor or Truck Mounted Hydraulic Crane (10 Tons or Under); Tractor (Scraper, Dozer, Pusher, Loader); Trencher (Wheel Type or Chain Type Having Over 8 Inch Bucket). | 32.32 | 18.18 | 50.50 |
| 502 | Backfiller; Broom or Sweeper; Bulldozer or Endloader (Under 40 hp); Environmental Burner; Forestry Equipment, Timbco, Tree Shear, Tub Grinder, Processor; Jeep Digger; Screed (Milling Machine); Skid Rig; Straddle Carrier or Travel Lift; Stump Chipper; Trencher (Wheel Type or Chain Type Having 8 Inch Bucket & Under). | 33.32 | 17.60 | 50.92 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 503 | Air Compressor (&/or 400 CFM or Over); Augers (Vertical & Horizontal); Compactor (Self-Propelled 84 Ft Total Drum Width & Under, or Tractor Mounted, Towed & Light Equipment); Crusher, Screening or Wash Plant; Farm or Industrial Type Tractor; Forklift; Generator (&/or 150 KW or Over); Greaser; High Pressure Utility Locating Machine (Daylighting Machine); Mulcher; Oiler; Post Hole Digger or Driver; Pump (3 Inch or Over) or Well Points; Refrigeration Plant or Freeze Machine; Rock, Stone Breaker; Skid Steer Loader (With or Without Attachments); Vibratory Hammer or Extractor, Power Pack. | 32.32 | 17.59 | 49.91 |
| 504 | Work Performed on the Great Lakes Including Diver; Wet Tender or Hydraulic Dredge Engineer. | 36.20 | 18.81 | 55.01 |
| 505 | Work Performed on the Great Lakes Including Crane or Backhoe Operator; Assistant Hydraulic Dredge Engineer; Hydraulic Dredge Leverman or Diver's Tender; Mechanic or Welder; 70 Ton & Over Tug Operator.<br>Premium Increase(s):<br>Add $.50/hr for friction crane, lattice boom or crane certification (CCO). | 37.45 | 19.45 | 56.90 |
| 506 | Work Performed on the Great Lakes Including Deck Equipment Operator or Machineryman (Maintains Cranes Over 50 Tons or Backhoes 115,000 Lbs. or More); Tug, Launch or Loader, Dozer or Like Equipment When Operated on a Barge, Breakwater Wall, Slip, Dock or Scow, Deck Machinery. | 26.80 | 18.52 | 45.32 |
| 507 | Work Performed on the Great Lakes Including Deck Equipment Operator, Machineryman or Fireman (Operates 4 Units or More or Maintains Cranes 50 Tons or Under or Backhoes 115,000 Lbs. or Under); Deck Hand, Deck Engineer or Assistant Tug Operator; Off Road Trucks - Great Lakes ONLY. | 27.75 | 19.15 | 46.90 |

## HEAVY EQUIPMENT OPERATORS
## EXCLUDING SITE PREPARATION, UTILITY, PAVING LANDSCAPING WORK

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 508 | Boring Machine (Directional); Crane, Tower Crane, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of Over 100 Tons, Self-Erecting Tower Crane With a Lifting Capacity of Over 4,000 Lbs., Crane With Boom Dollies; Crane, Tower Crane, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 176 Ft or Over; Master Mechanic.<br>Premium Increase(s):<br>Crane Operators with CCO certification add $.50/hr. Cranes with boom length over 200 ft. not exceeding 300 ft. OR lifting capacity over 200 ton not exceeding 300 ton add $.50/hr. Over 300 ton OR 300 ft. add $.01/hr. per foot OR ton whichever is greater. | 39.16 | 19.10 | 58.26 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 509 | Backhoe (Track Type) Having a Mfgr's Rated Capacity of 130,000 Lbs. or Over; Boring Machine (Horizontal or Vertical); Caisson Rig; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of 100 Tons or Under, Self-Erecting Tower Crane With A Lifting Capacity Of 4,000 Lbs. & Under; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 175 Ft or Under; Pile Driver; Versi Lifts, Tri-Lifts & Gantrys (20,000 Lbs. & Over).<br>Premium Increase(s):<br>Crane Operators with CCO certification add $.50/hr. | 38.66 | 19.10 | 57.76 |
| 510 | Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of Under 130,000 Lbs., Backhoe (Mini, 15,000 Lbs. & Under); Concrete Bump Cutter, Grinder, Planing or Grooving Machine; Concrete Laser/Screed; Concrete Paver (Slipform); Concrete Pump (Over 46 Meter), Concrete Conveyor (Rotec or Bidwell Type); Concrete Slipform Placer Curb & Gutter Machine; Concrete Spreader & Distributor; Dredge (NOT Performing Work on the Great Lakes); Forklift (Machinery Moving or Steel Erection, 25 Ft & Over); Gradall (Cruz-Aire Type); Hydro-Blaster (10,000 PSI or Over); Milling Machine; Skid Rig; Traveling Crane (Bridge Type).<br>Premium Increase(s):<br>Crane Operators with CCO certification add $.50/hr. | 38.16 | 19.10 | 57.26 |
| 511 | Air, Track, Rotary or Percussion Drilling Machine &/or Hammers, Blaster; Bulldozer or Endloader (Over 40 hp); Compactor (Self-Propelled 85 Ft Total Drum Width & Over, or Tractor Mounted, Towed & Light Equipment); Concrete Pump (46 Meter & Under), Concrete Conveyor (Rotec or Bidwell Type); Crane (Carry Deck, Mini) or Truck Mounted Hydraulic Crane (10 Tons or Under); Environmental Burner; Gantrys (Under 20,000 Lbs.); Grader or Motor Patrol; High Pressure Utility Locating Machine (Daylighting Machine); Manhoist; Material or Stack Hoist; Mechanic or Welder; Railroad Track Rail Leveling Machine, Tie Placer, Extractor, Tamper, Stone Leveler or Rehabilitation Equipment; Roller (Over 5 Ton); Scraper (Self Propelled or Tractor Drawn) 5 cu yd or More Capacity; Screed (Milling Machine); Sideboom; Straddle Carrier or Travel Lift; Tining or Curing Machine; Tractor (Scraper, Dozer, Pusher, Loader); Tractor or Truck Mounted Hydraulic Backhoe; Tractor or Truck Mounted Hydraulic Crane (10 Tons or Under); Trencher (Wheel Type or Chain Type Having Over 8-Inch Bucket).<br>Premium Increase(s):<br>Crane Operators with CCO certification add $.50/hr. | 38.16 | 19.10 | 57.26 |
| 512 | Backfiller; Broom or Sweeper; Bulldozer or Endloader (Under 40 hp); Compactor (Self-Propelled 84 Ft Total Drum Width & Under, or Tractor Mounted, Towed & Light Equipment); Concrete Batch Plant, Batch Hopper; Concrete Breaker (Large, Auto, Vibratory/Sonic, Manual or Remote); Concrete Conveyor System; Concrete Finishing Machine (Road Type); Fireman (Pile Driver & Derrick NOT Performing Work on the Great Lakes); Grout Pump; Hoist (Tugger, Automatic); Industrial Locomotives; Jeep Digger; Lift Slab Machine; Mulcher; Robotic Tool Carrier (With or Without Attachments); Roller (Rubber Tire, 5 Ton or Under); Screw or Gypsum Pumps; Stabilizing or Concrete Mixer (Self-Propelled or 14S or Over); Stump Chipper; Trencher (Wheel Type or Chain Type Having 8-Inch Bucket & Under); Winches & A-Frames. | 37.47 | 19.10 | 56.57 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 513 | Air Compressor (&/or 400 CFM or Over); Air, Electric or Hydraulic Jacking System; Augers (Vertical & Horizontal); Boatmen (NOT Performing Work on the Great Lakes); Boiler (Temporary Heat); Crusher, Screening or Wash Plant; Elevator; Farm or Industrial Type Tractor; Fireman (Asphalt Plant NOT Performing Work on the Great Lakes); Forklift; Generator (&/or 150 KW or Over); Greaser; Heaters (Mechanical); Loading Machine (Conveyor); Oiler; Post Hole Digger or Driver; Prestress Machine; Pump (3 Inch or Over) or Well Points; Refrigeration Plant or Freeze Machine; Rock, Stone Breaker; Skid Steer Loader (With or Without Attachments); Vibratory Hammer or Extractor, Power Pack. | 30.44 | 19.10 | 49.54 |
| 514 | Gas or Utility Pipeline, Except Sewer & Water (Primary Equipment).<br>Future Increase(s):<br>Add $2/hr. on 1/1/2013. | 34.89 | 19.68 | 54.57 |
| 515 | Gas or Utility Pipeline, Except Sewer & Water (Secondary Equipment). | 31.26 | 17.40 | 48.66 |
| 516 | Fiber Optic Cable Equipment | 25.74 | 15.85 | 41.59 |

## SEWER, WATER OR TUNNEL CONSTRUCTION

**Includes those projects that primarily involve public sewer or water distribution, transmission or collection systems and related tunnel work (excluding buildings).**

### SKILLED TRADES

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 103 | Bricklayer, Blocklayer or Stonemason | 35.53 | 15.92 | 51.45 |
| 105 | Carpenter<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 33.43 | 19.31 | 52.74 |
| 107 | Cement Finisher<br>Future Increase(s):<br>Add $1.86 on 6/1/12; Add $1.87 on 6/1/13; Add $1.87 on 6/1/14; Add $1.87 on 6/1/15; Add $1.75 on 6/1/16.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.40/hr when the Wisconsin Department of Transportation or responsible governing agency requires that work be performed at night under artificial illumination with traffic control and the work is completed after sunset and before sunrise. | 27.14 | 19.22 | 46.36 |
| 109 | Electrician<br>Future Increase(s):<br>Add $1.40/hr on 6/1/2012. Add $1.60/hr on 6/1/2013.<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year’s Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 31.54 | 20.95 | 52.49 |
| 111 | Fence Erector | 27.00 | 0.00 | 27.00 |
| 116 | Ironworker<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 31.31 | 22.22 | 53.53 |
| 118 | Line Constructor (Electrical) | 35.97 | 18.08 | 54.05 |
| 125 | Pavement Marking Operator | 26.00 | 0.00 | 26.00 |
| 126 | Piledriver | 28.11 | 23.94 | 52.05 |
| 130 | Plumber | 36.18 | 16.86 | 53.04 |
| 135 | Steamfitter | 35.81 | 19.04 | 54.85 |
| 137 | Teledata Technician or Installer | 24.65 | 15.17 | 39.82 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 143 | Tuckpointer, Caulker or Cleaner | 34.30 | 15.47 | 49.77 |
| 144 | Underwater Diver (Except on Great Lakes) | 36.20 | 18.81 | 55.01 |
| 146 | Well Driller or Pump Installer | 24.22 | 14.80 | 39.02 |
| 150 | Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY | 27.42 | 15.10 | 42.52 |
| 151 | Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY | 28.78 | 15.16 | 43.94 |
| 152 | Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY | 17.80 | 9.00 | 26.80 |
| 153 | Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY | 23.38 | 12.48 | 35.86 |
| 154 | Groundman - ELECTRICAL LINE CONSTRUCTION ONLY | 21.30 | 10.97 | 32.27 |

## TRUCK DRIVERS

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 201 | Single Axle or Two Axle | 23.00 | 8.64 | 31.64 |
| 203 | Three or More Axle | 17.54 | 13.41 | 30.95 |
| 204 | Articulated, Euclid, Dumptor, Off Road Material Hauler<br>Future Increase(s):<br>Add $1.75/hr on 6/1/2012; Add $1.85/hr on 6/1/2013.<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 22.50 | 16.19 | 38.69 |
| 205 | Pavement Marking Vehicle | 19.25 | 10.84 | 30.09 |
| 207 | Truck Mechanic | 17.54 | 13.41 | 30.95 |

## LABORERS

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 301 | General Laborer<br>Future Increase(s):<br>Add $1.73/hr on 6/4/2012.<br>Premium Increase(s):<br>Add $1.92 for bottomman; Add $2.03 for concrete manhole builder, bracer, jointman, or pipelayer; Add $4.83 for blaster. Add $2.00 for all tunnel work under 15 lbs. compressed air; Add $2.00 for 0-30 lbs. compressed air; Add $3.00 for over 30 lbs. compressed air. | 27.72 | 15.61 | 43.33 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 303 | Landscaper | 12.50 | 2.20 | 14.70 |
| 304 | Flagperson or Traffic Control Person | 22.50 | 12.90 | 35.40 |
| 311 | Fiber Optic Laborer (Outside, Other Than Concrete Encased) | 17.09 | 14.40 | 31.49 |
| 314 | Railroad Track Laborer | 17.00 | 1.06 | 18.06 |

**HEAVY EQUIPMENT OPERATORS**
**SEWER, WATER OR TUNNEL WORK**

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 521 | Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of 130,000 Lbs. or Over; Caisson Rig; Crane, Tower Crane, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 176 Ft or Over; Crane, Tower Crane, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of Over 100 Tons, Self-Erecting Tower Crane With a Lifting Capacity Of Over 4,000 Lbs., Crane With Boom Dollies; Master Mechanic; Pile Driver.<br>Premium Increase(s):<br>Crane Operators with CCO certification add $.50/hr. Cranes with boom length over 200 ft. not exceeding 300 ft. OR lifting capacity over 200 ton not exceeding 300 ton add $.50/hr. Over 300 ton OR 300 ft. add $.01/hr. per foot OR ton whichever is greater. | 39.16 | 19.10 | 58.26 |
| 522 | Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of Under 130,000 Lbs., Backhoe (Mini, 15,000 Lbs. & Under); Boring Machine (Directional); Concrete Bump Cutter, Grinder, Planing or Grooving Machine; Concrete Laser/Screed; Concrete Paver (Slipform); Concrete Pump (Over 46 Meter), Concrete Conveyor (Rotec or Bidwell Type); Concrete Spreader & Distributor; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 175 Ft or Under; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of 100 Tons or Under, Self-Erecting Tower Crane With a Lifting Capacity of 4,000 Lbs. & Under; Dredge (NOT Performing Work on the Great Lakes); Milling Machine; Skid Rig; Telehandler; Traveling Crane (Bridge Type).<br>Future Increase(s):<br>Add $2.05/hr on 6/4/2012.<br>Premium Increase(s):<br>Add $.25/hr for operating tower crane. | 33.91 | 18.55 | 52.46 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 523 | Air Track, Rotary or Percussion Drilling Machine &/or Hammers, Blaster; Boring Machine (Horizontal or Vertical); Bulldozer or Endloader (Over 40 hp); Crane (Carry Deck, Mini) or Truck Mounted Hydraulic Crane (10 Tons or Under); Concrete Pump (46 Meter & Under), Concrete Conveyor (Rotec or Bidwell Type); Concrete Slipform Placer Curb & Gutter Machine; Gradall (Cruz-Aire Type); Grader or Motor Patrol; Hydro-Blaster (10,000 PSI or Over); Manhoist; Material or Stack Hoist; Mechanic or Welder; Roller (Over 5 Ton); Scraper (Self Propelled or Tractor Drawn) 5 cu yd or More Capacity; Screed (Milling Machine); Sideboom; Straddle Carrier or Travel Lift; Tractor (Scraper, Dozer, Pusher, Loader); Tractor or Truck Mounted Hydraulic Backhoe; Tractor or Truck Mounted Hydraulic Crane (10 Tons or Under); Trencher (Wheel Type or Chain Type Having Over 8-Inch Bucket).<br>Future Increase(s):<br>Add $2.05/hr on 6/4/2012.<br>Premium Increase(s):<br>Add $.25/hr for operating tower crane. | 32.96 | 18.55 | 51.51 |
| 524 | Backfiller; Broom or Sweeper; Bulldozer or Endloader (Under 40 hp); Compactor (Self-Propelled 85 Ft Total Drum Width & Over, or Tractor Mounted, Towed & Light Equipment); Concrete Batch Plant, Batch Hopper; Concrete Breaker (Large, Auto, Vibratory/Sonic, Manual or Remote); Concrete Conveyor System; Concrete Finishing Machine (Road Type); Environmental Burner; Fireman (Pile Driver & Derrick NOT Performing Work on the Great Lakes); Forestry Equipment, Timbco, Tree Shear, Tub Grinder, Processor; Hoist (Tugger, Automatic); Grout Pump; Jeep Digger; Lift Slab Machine; Mulcher; Power Subgrader; Pump (3 Inch or Over) or Well Points; Robotic Tool Carrier (With or Without Attachments); Roller (Rubber Tire, 5 Ton or Under); Screw or Gypsum Pumps; Stabilizing or Concrete Mixer (Self-Propelled or 14S or Over); Stump Chipper; Tining or Curing Machine; Trencher (Wheel Type or Chain Type Having 8-Inch Bucket & Under); Winches & A-Frames. | 30.89 | 18.12 | 49.01 |
| 525 | Air Compressor (&/or 400 CFM or Over); Air, Electric or Hydraulic Jacking System; Augers (Vertical & Horizontal); Compactor (Self-Propelled 84 Ft Total Drum Width & Under, or Tractor Mounted, Towed & Light Equipment); Crusher, Screening or Wash Plant; Farm or Industrial Type Tractor; Fireman (Asphalt Plant NOT Performing Work on the Great Lakes); Generator (&/or 150 KW or Over); Heaters (Mechanical); High Pressure Utility Locating Machine (Daylighting Machine); Loading Machine (Conveyor); Post Hole Digger or Driver; Refrigeration Plant or Freeze Machine; Rock, Stone Breaker; Skid Steer Loader (With or Without Attachments); Vibratory Hammer or Extractor, Power Pack.<br>Future Increase(s):<br>Add $2.05/hr on 6/4/2012.<br>Premium Increase(s):<br>Add $.25/hr for operating tower crane. | 30.51 | 18.55 | 49.06 |
| 526 | Boiler (Temporary Heat); Forklift; Greaser; Oiler. | 29.44 | 18.10 | 47.54 |
| 527 | Work Performed on the Great Lakes Including Diver; Wet Tender or Hydraulic Dredge Engineer. | 36.20 | 18.81 | 55.01 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 528 | Work Performed on the Great Lakes Including 70 Ton & Over Tug Operator; Assistant Hydraulic Dredge Engineer; Crane or Backhoe Operator; Hydraulic Dredge Leverman or Diver's Tender; Mechanic or Welder. | 36.20 | 18.81 | 55.01 |
| 529 | Work Performed on the Great Lakes Including Deck Equipment Operator or Machineryman (Maintains Cranes Over 50 Tons or Backhoes 115,000 Lbs. or More); Tug, Launch or Loader, Dozer or Like Equipment When Operated on a Barge, Breakwater Wall, Slip, Dock or Scow, Deck Machinery. | 26.80 | 18.52 | 45.32 |
| 530 | Work Performed on the Great Lakes Including Deck Equipment Operator; Machineryman or Fireman (Operates 4 Units or More or Maintains Cranes 50 Tons or Under or Backhoes 115,000 Lbs. or Under), Deck Hand, Deck Engineer or Assistant Tug Operator; Off Road Trucks - Great Lakes ONLY. | 26.80 | 18.52 | 45.32 |

## AIRPORT PAVEMENT OR STATE HIGHWAY CONSTRUCTION

**Includes all airport projects (excluding buildings) and all projects awarded by the Wisconsin Department of Transportation (excluding buildings).**

### SKILLED TRADES

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 103 | Bricklayer, Blocklayer or Stonemason | 32.66 | 15.92 | 48.58 |
| 105 | Carpenter<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 33.43 | 19.31 | 52.74 |
| 107 | Cement Finisher<br>Future Increase(s):<br>Add $1.86 on 6/1/12; Add $1.87 on 6/1/13; Add $1.87 on 6/1/14; Add $1.87 on 6/1/15; Add $1.75 on 6/1/16.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.40/hr when the Wisconsin Department of Transportation or responsible governing agency requires that work be performed at night under artificial illumination with traffic control and the work is completed after sunset and before sunrise. | 29.33 | 17.03 | 46.36 |
| 109 | Electrician | 31.64 | 23.78 | 55.42 |
| 111 | Fence Erector | 35.62 | 0.00 | 35.62 |
| 116 | Ironworker | 31.31 | 21.54 | 52.85 |
| 118 | Line Constructor (Electrical) | 35.97 | 18.08 | 54.05 |
| 124 | Painter | 27.87 | 14.39 | 42.26 |
| 125 | Pavement Marking Operator | 27.87 | 14.39 | 42.26 |
| 126 | Piledriver<br>Premium Increase(s):<br>Add $.65/hr for Piledriver Loftsman; Add $.75/hr for Sheet Piling Loftsman. DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 29.56 | 24.96 | 54.52 |
| 133 | Roofer or Waterproofer | 28.85 | 14.60 | 43.45 |
| 137 | Teledata Technician or Installer | 24.65 | 15.17 | 39.82 |
| 143 | Tuckpointer, Caulker or Cleaner | 34.30 | 15.47 | 49.77 |
| 144 | Underwater Diver (Except on Great Lakes) | 36.20 | 18.81 | 55.01 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 150 | Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY | 33.87 | 16.10 | 49.97 |
| 151 | Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 29.64 | 14.64 | 44.28 |
| 152 | Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY | 25.18 | 13.07 | 38.25 |
| 153 | Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY | 23.38 | 12.48 | 35.86 |
| 154 | Groundman - ELECTRICAL LINE CONSTRUCTION ONLY | 21.30 | 10.97 | 32.27 |

**TRUCK DRIVERS**

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 201 | Single Axle or Two Axle<br>Future Increase(s):<br>Add $1.75/hr on 6/1/2012; Add $1.85/hr on 6/1/2013.<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 22.35 | 16.19 | 38.54 |
| 203 | Three or More Axle | 24.91 | 15.63 | 40.54 |
| 204 | Articulated, Euclid, Dumptor, Off Road Material Hauler<br>Future Increase(s):<br>Add $1.75/hr on 6/1/2012; Add $1.85/hr on 6/1/2013.<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 22.50 | 16.19 | 38.69 |
| 205 | Pavement Marking Vehicle | 23.84 | 14.70 | 38.54 |
| 206 | Shadow or Pilot Vehicle | 24.76 | 15.35 | 40.11 |
| 207 | Truck Mechanic | 24.91 | 15.63 | 40.54 |

## LABORERS

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 301 | General Laborer<br>Future Increase(s):<br>Add $1.60/hr on 6/1/2012: Add $1.70/hr on 6/1/2013; Add $1.60/hr on 6/1/2014.<br>Premium Increase(s):<br>Add $.15/hr for air tool operator, joint sawer and filler (pavement), vibrator or tamper operator (mechanical hand operated), chain saw operator and demolition burning torch laborer; Add $.35/hr for bituminous worker (raker and luteman), formsetter (curb, sidewalk and pavement) and strike off man; Add $.50/hr for line and grade specialist; Add $.65/hr for blaster and powderman; Add $2.01/hr for topman; Add $2.46/hr for bottomman; Add $3.23/hr for pipelayer. / DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 24.34 | 17.85 | 42.19 |
| 302 | Asbestos Abatement Worker | 22.00 | 16.86 | 38.86 |
| 303 | Landscaper | 23.71 | 15.03 | 38.74 |
| 304 | Flagperson or Traffic Control Person<br>Future Increase(s):<br>Add $1.60/hr on 6/1/2012; Add $1.70/hr on 6/1/2013; Add $1.60/hr on 6/1/2014.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year’s Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr when the Wisconsin Department of Transportation or responsible governing agency requires that work be performed at night under artificial illumination with traffic control and the work is completed after sunset and before sunrise. | 20.83 | 17.85 | 38.68 |
| 311 | Fiber Optic Laborer (Outside, Other Than Concrete Encased) | 17.09 | 14.40 | 31.49 |
| 314 | Railroad Track Laborer | 17.00 | 1.06 | 18.06 |

## HEAVY EQUIPMENT OPERATORS
## AIRPORT PAVEMENT OR STATE HIGHWAY CONSTRUCTION

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 531 | Crane, Tower Crane, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 176 Ft or Over; Crane, Tower Crane, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of Over 100 Tons, Self-Erecting Tower Crane With a Lifting Capacity Of Over 4,000 Lbs., Crane With Boom Dollies; Traveling Crane (Bridge Type).<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 34.22 | 18.90 | 53.12 |
| 532 | Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of 130,000 Lbs. or Over; Caisson Rig; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 175 Ft or Under; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of 100 Tons or Under, Self-Erecting Tower Crane With A Lifting Capacity Of 4,000 Lbs., & Under; Dredge (NOT Performing Work on the Great Lakes); Licensed Boat Pilot (NOT Performing Work on the Great Lakes); Pile Driver.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 33.72 | 18.90 | 52.62 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 533 | Air Track, Rotary or Percussion Drilling Machine &/or Hammers, Blaster; Asphalt Heater, Planer & Scarifier; Asphalt Milling Machine; Asphalt Screed; Automatic Subgrader (Concrete); Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of Under 130,000 Lbs., Backhoe (Mini, 15,000 Lbs. & Under); Bituminous (Asphalt) Plant & Paver, Screed; Boatmen (NOT Performing Work on the Great Lakes); Boring Machine (Directional, Horizontal or Vertical); Bridge (Bidwell) Paver; Bulldozer or Endloader; Concrete Batch Plant, Batch Hopper; Concrete Breaker (Large, Auto, VIbratory/Sonic, Manual or Remote); Concrete Bump Cutter, Grinder, Planing or Grooving Machine; Concrete Conveyor System; Concrete Laser/Screed; Concrete Paver (Slipform); Concrete Pump, Concrete Conveyor (Rotec or Bidwell Type); Concrete Slipform Placer Curb & Gutter Machine; Concrete Spreader & Distributor; Crane (Carry Deck, Mini) or Truck Mounted Hydraulic Crane (10 Tons or Under); Crane WIth a Lifting Capacity of 25 Tons or Under; Forestry Equipment, Timbco, Tree Shear, Tub Grinder, Processor; Gradall (Cruz-Aire Type); Grader or Motor Patrol; Grout Pump; Hydro-Blaster (10,000 PSI or Over); Loading Machine (Conveyor); Material or Stack Hoist; Mechanic or Welder; Milling Machine; Post Hole Digger or Driver; Roller (Over 5 Ton); Scraper (Self Propelled or Tractor Drawn) 5 cu yds or More Capacity; Shoulder Widener; Sideboom; Skid Rig; Stabilizing or Concrete Mixer (Self-Propelled or 14S or Over); Straddle Carrier or Travel Lift; Tractor (Scraper, Dozer, Pusher, Loader); Tractor or Truck Mounted Hydraulic Backhoe; Trencher (Wheel Type or Chain Type); Tube Finisher; Tugger (NOT Performing Work on the Great Lakes); Winches & A-Frames.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 33.22 | 18.90 | 52.12 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 534 | Belting, Burlap, Texturing Machine; Broom or Sweeper; Compactor (Self-Propelled or Tractor Mounted, Towed & Light Equipment); Concrete Finishing Machine (Road Type); Environmental Burner; Farm or Industrial Type Tractor; Fireman (Asphalt Plant, Pile Driver & Derrick NOT Performing Work on the Great Lakes); Forklift; Greaser; Hoist (Tugger, Automatic); Jeep Digger; Joint Sawer (Multiple Blade); Launch (NOT Performing Work on the Great Lakes); Lift Slab Machine; Mechanical Float; Mulcher; Power Subgrader; Robotic Tool Carrier (With or Without Attachments); Roller (Rubber Tire, 5 Ton or Under); Self Propelled Chip Spreader; Shouldering Machine; Skid Steer Loader (With or WIthout Attachments); Telehandler; Tining or Curing Machine.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 32.96 | 18.90 | 51.86 |
| 535 | Air Compressor (&/or 400 CFM or Over); Air, Electric or Hydraulic Jacking System; Augers (Vertical & Horizontal); Automatic Belt Conveyor & Surge Bin; Boiler (Temporary Heat); Concrete Proportioning Plant; Crusher, Screening or Wash Plant; Generator (&/or 150 KW or Over); Heaters (Mechanical); High Pressure Utility Locating Machine (Daylighting Machine); Mudjack; Oiler; Prestress Machine; Pug Mill; Pump (3 Inch or Over) or Well Points; Rock, Stone Breaker; Screed (Milling Machine); Stump Chipper; Tank Car Heaters; Vibratory Hammer or Extractor, Power Pack.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 32.67 | 18.90 | 51.57 |
| 536 | Fiber Optic Cable Equipment. | 24.39 | 15.45 | 39.84 |
| 537 | Work Performed on the Great Lakes Including Diver; Wet Tender or Hydraulic Dredge Engineer. | 36.20 | 18.81 | 55.01 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 538 | Work Performed on the Great Lakes Including 70 Ton & Over Tug Operator; Assistant Hydraulic Dredge Engineer; Crane or Backhoe Operator; Hydraulic Dredge Leverman or Diver's Tender; Mechanic or Welder. | 36.20 | 18.81 | 55.01 |
| 539 | Work Performed on the Great Lakes Including Deck Equipment Operator or Machineryman (Maintains Cranes Over 50 Tons or Backhoes 115,000 Lbs. or More); Tug, Launch or Loader, Dozer or Like Equipment When Operated on a Barge, Breakwater Wall, Slip, Dock or Scow, Deck Machinery. | 26.80 | 18.52 | 45.32 |
| 540 | Work Performed on the Great Lakes Including Deck Equipment Operator, Machineryman or Fireman (Operates 4 Units or More or Maintains Cranes 50 Tons or Under or Backhoes 115,000 Lbs. or Under); Deck Hand, Deck Engineer or Assistant Tug Operator; Off Road Trucks-Great Lakes ONLY. | 26.80 | 18.52 | 45.32 |

## LOCAL STREET OR MISCELLANEOUS PAVING CONSTRUCTION

**Includes roads, streets, alleys, trails, bridges, paths, racetracks, parking lots and driveways (except residential or agricultural), public sidewalks or other similar projects (excluding projects awarded by the Wisconsin Department of Transportation).**

### SKILLED TRADES

**Fringe Benefits Must Be Paid On All Hours Worked**

| CODE | TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 103 | Bricklayer, Blocklayer or Stonemason | 35.53 | 15.92 | 51.45 |
| 105 | Carpenter | 29.06 | 15.16 | 44.22 |
| 107 | Cement Finisher | 27.57 | 16.33 | 43.90 |
| 109 | Electrician<br>Future Increase(s):<br>Add $.50/hr. effective 06/04/2012.<br>Premium Increase(s):<br>DOT PREMIUM: Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. | 28.74 | 17.86 | 46.60 |
| 111 | Fence Erector | 27.00 | 0.00 | 27.00 |
| 116 | Ironworker | 31.31 | 21.54 | 52.85 |
| 118 | Line Constructor (Electrical) | 35.97 | 18.08 | 54.05 |
| 124 | Painter | 28.47 | 16.74 | 45.21 |
| 125 | Pavement Marking Operator | 26.00 | 0.00 | 26.00 |
| 126 | Piledriver | 28.11 | 23.94 | 52.05 |
| 133 | Roofer or Waterproofer | 28.85 | 14.60 | 43.45 |
| 137 | Teledata Technician or Installer | 24.65 | 15.17 | 39.82 |
| 143 | Tuckpointer, Caulker or Cleaner | 34.30 | 15.47 | 49.77 |
| 144 | Underwater Diver (Except on Great Lakes) | 36.20 | 18.81 | 55.01 |
| 150 | Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY | 35.42 | 12.90 | 48.32 |
| 151 | Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY | 28.78 | 14.42 | 43.20 |
| 152 | Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY | 25.18 | 13.07 | 38.25 |
| 153 | Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY | 23.38 | 12.48 | 35.86 |
| 154 | Groundman - ELECTRICAL LINE CONSTRUCTION ONLY | 21.30 | 10.97 | 32.27 |

## TRUCK DRIVERS

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 201 | Single Axle or Two Axle | 15.00 | 0.00 | 15.00 |
| 203 | Three or More Axle | 20.00 | 6.00 | 26.00 |
| 204 | Articulated, Euclid, Dumptor, Off Road Material Hauler<br>Future Increase(s):<br>Add $1/hr on 6/3/2012; Add $1/hr on 6/2/2013. | 31.89 | 17.98 | 49.87 |
| 205 | Pavement Marking Vehicle | 19.25 | 10.84 | 30.09 |
| 206 | Shadow or Pilot Vehicle | 15.00 | 0.00 | 15.00 |
| 207 | Truck Mechanic | 20.00 | 6.00 | 26.00 |

## LABORERS

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 301 | General Laborer | 21.73 | 17.04 | 38.77 |
| 303 | Landscaper | 22.96 | 15.37 | 38.33 |
| 304 | Flagperson or Traffic Control Person<br>Future Increase(s):<br>Add $1.60/hr on 6/1/2012; Add $1.70/hr on 6/1/2013; Add $1.60/hr on 6/1/2014.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr when the Wisconsin Department of Transportation or responsible governing agency requires that work be performed at night under artificial illumination with traffic control and the work is completed after sunset and before sunrise. | 23.55 | 13.45 | 37.00 |
| 311 | Fiber Optic Laborer (Outside, Other Than Concrete Encased) | 17.09 | 14.40 | 31.49 |
| 314 | Railroad Track Laborer | 17.00 | 1.06 | 18.06 |

## HEAVY EQUIPMENT OPERATORS
## CONCRETE PAVEMENT OR BRIDGE WORK

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 541 | Crane, Tower Crane, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of Over 100 Tons, Self-Erecting Tower Crane With a Lifting Capacity Of Over 4,000 Lbs., Crane With Boom Dollies; Crane, Tower Crane, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 176 Ft or Over; Master Mechanic.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 34.22 | 18.90 | 53.12 |
| 542 | Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of 130,000 Lbs. or Over; Caisson Rig; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of 100 Tons or Under, Self-Erecting Tower Crane With a Lifting Capacity of 4,000 Lbs. & Under; Crane, Tower Crane Portable Tower, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 175 Ft or Under; Dredge (NOT Performing Work on the Great Lakes); Licensed Boat Pilot (NOT Performing Work on the Great Lakes); Pile Driver.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 33.72 | 18.90 | 52.62 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 543 | Air Track, Rotary or Percussion Drilling Machine &/or Hammers, Blaster; Automatic Subgrader (Concrete); Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of Under 130,000 Lbs., Backhoe (Mini, 15,000 Lbs. & Under); Boring Machine (Directional, Horizontal or Vertical); Bridge (Bidwell) Paver; Bulldozer or Endloader; Concrete Batch Plant, Batch Hopper; Concrete Breaker (Large, Auto, Vibratory/Sonic, Manual or Remote); Concrete Bump Cutter, Grinder, Planing or Grooving Machine; Concrete Conveyor System; Concrete Laser/Screed; Concrete Paver (Slipform); Concrete Pump, Concrete Conveyor (Rotec or Bidwell Type); Concrete Slipform Placer Curb & Gutter Machine; Concrete Spreader & Distributor; Crane (Carry Deck, Mini) or Truck Mounted Hydraulic Crane (10 Tons or Under); Crane With a Lifting Capacity of 25 Tons or Under; Forestry Equipment, Timbco, Tree Shear, Tub Grinder, Processor; Gradall (Cruz-Aire Type); Grader or Motor Patrol; Grout Pump; Hydro-Blaster (10,000 PSI or Over); Loading Machine (Conveyor); Manhoist; Material or Stack Hoist; Mechanic or Welder; Milling Machine; Post Hole Digger or Driver; Scraper (Self Propelled or Tractor Drawn) 5 cu yds or More Capacity; Shoulder Widener; Sideboom; Skid Rig; Stabilizing or Concrete Mixer (Self-Propelled or 14S or Over); Straddle Carrier or Travel Lift; Tractor (Scraper, Dozer, Pusher, Loader); Tractor or Truck Mounted Hydraulic Backhoe; Trencher (Wheel Type or Chain Type); Tube Finisher; Tugger (NOT Performing Work on the Great Lakes); Winches & A-Frames. | 31.89 | 18.22 | 50.11 |
| 544 | Backfiller; Belting, Burlap, Texturing Machine; Broom or Sweeper; Compactor (Self-Propelled or Tractor Mounted, Towed & Light Equipment); Concrete Finishing Machine (Road Type); Environmental Burner; Farm or Industrial Type Tractor; Fireman (Pile Driver & Derrick NOT Performing Work on the Great Lakes); Forklift; Greaser; Jeep Digger; Joint Sawer (Multiple Blade); Launch (NOT Performing Work on the Great Lakes); Lift Slab Machine; Mechanical Float; Mulcher; Power Subgrader; Robotic Tool Carrier (WIth or Without Attachments); Self Propelled Chip Spreader; Shouldering Machine; Skid Steer Loader (With or Without Attachments); Telehandler; Tining or Curing Machine.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 33.22 | 18.90 | 52.12 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 545 | Air Compressor (&/or 400 CFM or Over); Air, Electric or Hydraulic Jacking System; Automatic Belt Conveyor & Surge Bin; Boiler (Temporary Heat); Concrete Proportioning Plant; Crusher, Screening or Wash Plant; Generator (&/or 150 KW or Over); Heaters (Mechanical); High Pressure Utility Locating Machine (Daylighting Machine); Mudjack; Oiler; Prestress Machine; Pug Mill; Pump (3 Inch or Over) or Well Points; Rock, Stone Breaker; Screed (Milling Machine); Stump Chipper; Tank Car Heaters; Vibratory Hammer or Extractor, Power Pack. | 30.42 | 17.58 | 48.00 |
| 546 | Fiber Optic Cable Equipment. | 24.39 | 15.45 | 39.84 |
| 547 | Work Performed on the Great Lakes Including Diver; Wet Tender or Hydraulic Dredge Engineer. | 36.20 | 18.81 | 55.01 |
| 548 | Work Performed on the Great Lakes Including 70 Ton & Over Tug Operator; Assistant Hydraulic Dredge Engineer; Crane or Backhoe Operator; Hydraulic Dredge Leverman or Diver's Tender; Mechanic or Welder. | 36.20 | 18.81 | 55.01 |
| 549 | Work Performed on the Great Lakes Including Deck Equipment Operator or Machineryman (Maintains Cranes Over 50 Tons or Backhoes 115,000 Lbs. or more); Tug, Launch or Loader, Dozer or Like Equipment When Operated on a Barge, Breakwater Wall, Slip, Dock or Scow, Deck Machinery. | 26.80 | 18.52 | 45.32 |
| 550 | Work Performed on the Great Lakes Including Deck Equipment Operator; Machineryman or Fireman (Operates 4 Units or More or Maintains Cranes 50 Tons or Under or Backhoes 115,000 Lbs. or Under); Deck Hand, Deck Engineer or Assistant Tug Operator; Off Road Trucks - Great Lakes ONLY. | 26.80 | 18.52 | 45.32 |

## HEAVY EQUIPMENT OPERATORS
## ASPHALT PAVEMENT OR OTHER WORK

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 551 | Crane, Tower Crane, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of Over 100 Tons, Self Erecting Tower Crane With a Lifting Capacity of Over 4,000 Lbs., Crane With Boom Dollies; Crane, Tower Crane, Pedestal Tower or Derrick, With Boom, Leads and/or Jib Lengths Measuring 176 Ft or Over; Master Mechanic. | 38.06 | 18.10 | 56.16 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 552 | Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of 130,000 Lbs. or Over; Caisson Rig; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With or Without Attachments, With a Lifting Capacity of 100 Tons or Under, Self-Erecting Tower Crane With a Lifting Capacity Of 4,000 Lbs. & Under; Crane, Tower Crane, Portable Tower, Pedestal Tower or Derrick, With Boom, Leads &/or Jib Lengths Measuring 175 Ft or Under; Dredge (NOT Performing Work on the Great Lakes); Licensed Boat Pilot (NOT Performing Work on the Great Lakes); Pile Driver.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14.<br>Premium Increase(s):<br>DOT PREMIUMS: 1) Pay two times the hourly basic rate on Sunday, New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day. 2) Add $1.25/hr for work on projects involving temporary traffic control setup, for lane and shoulder closures, when work under artificial illumination conditions is necessary as required by the project provisions (including prep time prior to and/or cleanup after such time period). | 33.72 | 18.90 | 52.62 |
| 553 | Air, Track, Rotary or Percussion Drilling Machine &/or Hammers, Blaster; Asphalt Heater, Planer & Scarifier; Asphalt Milling Machine; Asphalt Screed; Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of Under 130,000 Lbs., Backhoe (Mini, 15,000 Lbs. & Under); Bituminous (Asphalt) Plant & Paver, Screed; Boring Machine (Directional, Horizontal or Vertical); Bulldozer or Endloader; Concrete Breaker (Large, Auto, Vibratory/Sonic, Manual or Remote); Concrete Conveyor System; Concrete Laser/Screed; Concrete Slipform Placer Curb & Gutter Machine; Crane (Carry Deck, Mini) or Truck Mounted Hydraulic Crane (10 Tons or Under); Crane With a Lifting Capacity of 25 Tons or Under; Forestry Equipment, Timbco, Tree Shear, Tub Grinder, Processor; Gradall (Cruz-Aire Type); Grader or Motor Patrol; Hydro-Blaster (10,000 PSI or Over); Loading Machine (Conveyor); Manhoist; Material or Stack Hoist; Mechanic or Welder; Milling Machine; Post Hole Digger or Driver; Railroad Track Rail Leveling Machine, Tie Placer, Extractor, Tamper, Stone Leveler or Rehabilitation Equipment; Roller (Over 5 Ton); Scraper (Self Propelled or Tractor Drawn) 5 cu yds or More Capacity; Shoulder Widener; Sideboom; Skid Rig; Stabilizing or Concrete Mixer (Self-Propelled or 14S or Over); Tractor (Scraper, Dozer, Pusher, Loader); Tractor or Truck Mounted Hydraulic Backhoe; Trencher (Wheel Type or Chain Type); Tube Finisher; Tugger (NOT Performing Work on the Great Lakes); Winches & A-Frames. | 31.52 | 17.50 | 49.02 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 554 | Backfiller; Broom or Sweeper; Compactor (Self-Propelled or Tractor Mounted, Towed & Light Equipment); Concrete Finishing Machine (Road Type); Environmental Burner; Farm or Industrial Type Tractor; Fireman (Asphalt Plant, Pile Driver & Derrick NOT Performing Work on the Great Lakes); Forklift; Greaser; Hoist (Tugger, Automatic); Jeep Digger; Joint Sawer (Multiple Blade); Launch (NOT Performing Work on the Great Lakes); Lift Slab Machine; Mechanical Float; Mulcher; Power Subgrader; Robotic Tool Carrier (With or Without Attachments); Roller (Rubber Tire, 5 Ton or Under); Self-Propelled Chip Spreader; Shouldering Machine; Skid Steer Loader (With or Without Attachments); Telehandler.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14. | 32.67 | 18.55 | 51.22 |
| 555 | Air Compressor (&/or 400 CFM or Over); Air, Electric or Hydraulic Jacking System; Augers (Vertical & Horizontal); Automatic Belt Conveyor & Surge Bin; Boiler (Temporary Heat); Crusher, Screening or Wash Plant; Generator (&/or 150 KW or Over); Heaters (Mechanical); High Pressure Utility Locating Machine (Daylighting Machine); Mudjack; Oiler; Prestress Machine; Pug Mill; Pump (3 Inch or Over) or Well Points; Rock, Stone Breaker; Screed (Milling Machine); Stump Chipper; Tank Car Heaters; Vibratory Hammer or Extractor, Power Pack.<br>Future Increase(s):<br>Add $2/hr on 6/1/12; Add $2/hr on 6/1/13; Add $1.75/hr on 6/1/14. | 32.67 | 18.55 | 51.22 |
| 556 | Fiber Optic Cable Equipment. | 24.39 | 15.45 | 39.84 |

## RESIDENTIAL OR AGRICULTURAL CONSTRUCTION

**Includes single family houses or apartment buildings of no more than four (4) stories in height and all buildings, structures or facilities that are primarily used for agricultural or farming purposes, excluding commercial buildings. For classification purposes, the exterior height of a residential building, in terms of stories, is the primary consideration. All incidental items such as site work, driveways, parking lots, private sidewalks, private septic systems or sewer and water laterals connected to a public system and swimming pools are included within this definition. Residential buildings of five (5) stories and above are NOT included within this definition.**

### SKILLED TRADES

**Fringe Benefits Must Be Paid On All Hours Worked**

| CODE | TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY $ | HOURLY FRINGE BENEFITS $ | TOTAL $ |
|---|---|---|---|---|
| 101 | Acoustic Ceiling Tile Installer | 27.00 | 1.16 | 28.16 |
| 102 | Boilermaker | 31.09 | 21.87 | 52.96 |
| 103 | Bricklayer, Blocklayer or Stonemason | 26.22 | 13.80 | 40.02 |
| 104 | Cabinet Installer | 26.00 | 2.33 | 28.33 |
| 105 | Carpenter | 31.68 | 7.03 | 38.71 |
| 106 | Carpet Layer or Soft Floor Coverer | 21.40 | 6.01 | 27.41 |
| 107 | Cement Finisher | 28.00 | 10.10 | 38.10 |
| 108 | Drywall Taper or Finisher<br>Future Increase(s):<br>Add $2.20/hr on 6/1/2012 | 28.97 | 17.74 | 46.71 |
| 109 | Electrician | 31.10 | 6.01 | 37.11 |
| 110 | Elevator Constructor | 43.79 | 25.48 | 69.27 |
| 111 | Fence Erector | 17.64 | 4.66 | 22.30 |
| 112 | Fire Sprinkler Fitter | 36.39 | 16.97 | 53.36 |
| 113 | Glazier | 36.23 | 8.04 | 44.27 |
| 114 | Heat or Frost Insulator | 29.04 | 19.73 | 48.77 |
| 115 | Insulator (Batt or Blown) | 11.00 | 2.51 | 13.51 |
| 116 | Ironworker | 23.05 | 4.06 | 27.11 |
| 117 | Lather | 28.15 | 15.14 | 43.29 |
| 119 | Marble Finisher | 31.16 | 16.27 | 47.43 |
| 120 | Marble Mason | 35.53 | 15.92 | 51.45 |
| 121 | Metal Building Erector | 15.19 | 2.00 | 17.19 |
| 123 | Overhead Door Installer | 23.00 | 8.00 | 31.00 |
| 124 | Painter | 23.00 | 2.81 | 25.81 |

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 125 | Pavement Marking Operator | 26.00 | 0.00 | 26.00 |
| 129 | Plasterer | 30.36 | 7.15 | 37.51 |
| 130 | Plumber | 37.42 | 17.92 | 55.34 |
| 132 | Refrigeration Mechanic | 25.00 | 0.51 | 25.51 |
| 133 | Roofer or Waterproofer<br>Future Increase(s):<br>Add $.50/hr. effective 06/01/2012 | 29.40 | 15.05 | 44.45 |
| 134 | Sheet Metal Worker | 28.15 | 15.14 | 43.29 |
| 135 | Steamfitter | 32.59 | 11.05 | 43.64 |
| 137 | Teledata Technician or Installer | 19.23 | 5.32 | 24.55 |
| 138 | Temperature Control Installer | 22.00 | 2.64 | 24.64 |
| 139 | Terrazzo Finisher | 18.00 | 5.35 | 23.35 |
| 140 | Terrazzo Mechanic | 31.16 | 16.27 | 47.43 |
| 141 | Tile Finisher | 23.96 | 15.50 | 39.46 |
| 142 | Tile Setter | 27.00 | 1.91 | 28.91 |
| 143 | Tuckpointer, Caulker or Cleaner | 32.50 | 1.62 | 34.12 |
| 146 | Well Driller or Pump Installer | 27.60 | 0.00 | 27.60 |
| 147 | Siding Installer | 16.00 | 0.00 | 16.00 |

**TRUCK DRIVERS**

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 201 | Single Axle or Two Axle | 16.25 | 2.25 | 18.50 |
| 203 | Three or More Axle | 17.00 | 7.63 | 24.63 |
| 205 | Pavement Marking Vehicle | 19.25 | 10.84 | 30.09 |
| 207 | Truck Mechanic | 19.00 | 1.75 | 20.75 |

## LABORERS

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 301 | General Laborer | 17.50 | 6.16 | 23.66 |
| 302 | Asbestos Abatement Worker | 17.00 | 2.21 | 19.21 |
| 303 | Landscaper | 11.00 | 2.07 | 13.07 |
| 311 | Fiber Optic Laborer (Outside, Other Than Concrete Encased) | 17.09 | 14.40 | 31.49 |

## HEAVY EQUIPMENT OPERATORS RESIDENTIAL OR AGRICULTURAL CONSTRUCTION

| CODE | Fringe Benefits Must Be Paid On All Hours Worked<br>TRADE OR OCCUPATION | HOURLY BASIC RATE OF PAY<br>$ | HOURLY FRINGE BENEFITS<br>$ | TOTAL<br>$ |
|---|---|---|---|---|
| 557 | Asphalt Heater, Planer & Scarifier; Asphalt Milling Machine; Asphalt Screed; Backhoe (Track Type); Backhoe (Mini, 15,000 Lbs. & Under); Bituminous (Asphalt) Plant & Paver, Screed; Boring Machine (Directional, Horizontal or Vertical); Bulldozer or Endloader; Concrete Breaker (Large, Auto, VIbratory/Sonic, Manual or Remote); Concrete Bump Cutter, Grinder, Planing or Grooving Machine; Concrete Conveyor System; Concrete Laser/Screed; Concrete Paver (Slipform); Concrete Pump, Concrete Conveyor (Rotec or Bidwell Type); Concrete Slipform Placer Curb & Gutter Machine; Concrete Spreader & DIstributor; Crane (Carry Deck, Mini) or Truck Mounted Hydraulic Crane (10 Tons or Under); Crane With a Lifting Capacity of 25 Tons or Under; Crane, Shovel, Dragline, Clamshells; Forestry Equipment, TImbco, Tree Shear, Tub Grinder, Processor; Grader or Motor Patrol; Grout Pump; Hydro-Blaster (10,000 PSI or Over); Loading Machine (Conveyor); Manhoist; Material or Stack Hoist; Mechanic or Welder; Milling Machine; Roller (Over 5 Ton); Scraper (Self Propelled or Tractor Drawn) 5 cu yds or More Capacity; Shoulder Widener; Skid Rig; Stabilizing or Concrete Mixer (Self-Propelled or 14S or Over); Tractor (Scraper, Dozer, Pusher, Loader); Tractor or Truck Mounted Hydraulic Backhoe; Tractor or Truck Mounted Hydraulic Crane (10 Tons or Under); Trencher (Wheel Type or Chain Type); WInches & A-Frames. | 32.56 | 10.76 | 43.32 |
| 558 | Air Compressor (&/or 400 CFM or Over); Air, Electric or Hydraulic Jacking System; Backfiller; Belting, Burlap, Texturing Machine; Boiler (Temporary Heat); Broom or Sweeper; Compactor (Self-Propelled or Tractor Mounted, Towed & LIght Equipment); Concrete Finishing Machine (Road Type); Farm or Industrial Type Tractor; Forklift; Generator (&/or 150 KW or Over); Heaters (Mechanical); High Pressure Utility Locating Machine (Daylighting Machine); Jeep Digger; Lift Slab Machine; Mulcher; Oiler; Post Hole Digger or Driver; Power Subgrader; Pump (3 Inch or Over) or Well Points; Robotic Tool Carrier (With or Without Attachments); Rock, Stone Breaker; Roller (Rubber Tire, 5 Tons or Under); Screed (Milling Machine); Self Propelled Chip Spreader; Shouldering Machine; Skid Steer Loader (With or Without Attachments); Stump Chipper; Telehandler; Vibratory Hammer or Extractor, Power Pack. | 17.40 | 0.44 | 17.84 |

********** END OF RATES **********

SECTION 00850: DRAWING SCHEDULE

The following listed drawings accompany and form a part of the project contract documents along with this project manual and generally illustrate the nature of the work.

See Section 00870 for additional drawings which are included within this project manual.

GENERAL

| | |
|---|---|
| G000 | SHEET INDEX |

ARCHITECTURAL SITE

| | |
|---|---|
| AS100 | SITE STAGING PLAN |

STRUCTURAL

| | |
|---|---|
| S100 | FRAMING PLAN & DETAILS |
| S101 | ROOF FRAMING PLAN |
| S200 | FRAMING DETAILS |

ARCHITECTURAL

| | |
|---|---|
| A001 | EXTERIOR/INTERIOR WALL ASSEMBLIES, SCHEDULES |
| A100.1 | BASEMENT PLAN |
| A101 | FIRST FLOOR DEMOLITION AND TEMPORARY |
| A101.1 | FIRST FLOOR PLAN |
| A102 | SECOND FLOOR DEMOLITION AND TEMPORARY RELOCATION PLAN |
| A102.1 | SECOND FLOOR PLAN |
| A103 | THIRD FLOOR DEMOLITION AND TEMPORARY RELOCATION PLAN |
| A103.1 | THIRD FLOOR PLAN |
| A104 | FOURTH FLOOR DEMOLITION AND TEMPORARY RELOCATION PLAN |
| A104.1 | FOURTH FLOOR PLAN |
| A105 | FIFTH FLOOR DEMOLITION AND TEMPORARY RELOCATION PLAN |
| A105.1 | FIFTH FLOOR PLAN |
| A106 | SIXTH FLOOR DEMOLITION AND TEMPORARY RELOCATION PLAN |
| A106.1 | SIXTH FLOOR PLAN |
| A107 | SEVENTH FLOOR DEMOLITION AND TEMPORARY RELOCATION PLAN |
| A107.1 | SEVENTH FLOOR PLAN |
| A108 | EIGHTH FLOOR DEMOLITION AND FLOOR PLAN |
| A109 | ROOF PLAN & DETAILS |
| A200 | ELEVATIONS & SECTION |

| | |
|---|---|
| A400 | ENLARGED SHAFT VIEWS |
| A500 | DETAILS |

FIRE PROTECTION

| | |
|---|---|
| FD100A | SUB-BASEMENT & BASEMENT FIRE PROTECTION DEMOLITION PLANS |
| F000 | FIRE PROTECTION SCHEDULES, SCHEMATICS, LEGEND & NOTES |
| F100A | SUB-BASEMENT & BASEMENT FIRE PROTECTION PLANS |

MECHANICAL

| | |
|---|---|
| M000 | MECHANICAL SYMBOLS, SCHEDULES & ABBREVIATIONS |
| M100 | BASEMENT & FIRST FLOOR HVAC PLANS |
| M102 | SECOND FLOOR HVAC PLANS |
| M103 | THIRD & FOURTH FLOOR HVAC PLANS |
| M105 | FIFTH & SIXTH FLOOR HVAC PLANS |
| M107 | SEVENTH FLOOR HVAC PLAN |
| M108 | EIGHTH FLOOR HVAC PLAN |
| M109 | ROOF/PENTHOUSE HVAC PLAN |
| M300 | MECHANICAL SECTIONS |
| M400 | PRESSURIZATION SCHEMATIC |
| MP200 | SUB-BASEMENT & BASEMENT MECHANICAL AND PLUMBING PIPING PLANS |
| MP201 | FIRST THROUGH SIXTH FLOOR MECHANICAL AND PLUMBING PIPING PLANS |
| MP202 | SEVENTH & EIGHTH FLOOR MECHANICAL & PLUMBING PIPING PLANS |
| MP300 | MECHANICAL AND PLUMBING PIPING ISOMETRIC |

ELECTRICAL

| | |
|---|---|
| E000 | ELECTRICAL SYMBOLS AND ABBREVIATIONS |
| E100A | SUB BASEMENT ELECTRICAL PLAN |
| E100 | BASEMENT ELECTRICAL PLAN |
| E101 | FIRST FLOOR ELECTRICAL PLAN |
| E102 | SECOND FLOOR ELECTRICAL PLAN |
| E103 | THIRD FLOOR ELECTRICAL PLAN |
| E104 | FOURTH FLOOR ELECTRICAL PLAN |
| E105 | FIFTH FLOOR ELECTRICAL PLAN |
| E106 | SIXTH FLOOR ELECTRICAL PLAN |
| E107 | SEVENTH FLOOR ELECTRICAL PLAN |
| E108 | EIGHTH FLOOR ELECTRICAL PLAN |
| E109 | PENTHOUSE FLOOR ELECTRICAL PLAN |
| E500 | PARTIAL EXISTING ONE-LINE DIAGRAM |

| | |
|---|---|
| E501 | PARTIAL PROPOSED EXISTING ONE-LINE DIAGRAM |
| E502 | FIRE ALARM INTERCONNECT DIAGRAM |
| E600 | SCHEDULES |

NOTE: SUPPLEMENTAL DRAWING INFORMATION

Construction documents of the original Police Administration Building and subsequent alteration work are available for contractors use. These documents are on file in the City of Milwaukee Department of Public Works Offices.

SECTION 01010: SUMMARY OF WORK:

1. SCOPE:

A. Index:

1. Scope
2. Project Description
3. Work by Others
4. Scheduling of Work

2. PROJECT DESCRIPTION:

A. The Police Department will occupy and continue to operate from this building during the construction. The contractor is required to coordinate all construction with City forces on site, to minimize impact to City operations and to ensure the safety of City employees and property. Coordination shall include the placement of field offices, interruption of utility service, demolition of the existing building, site clearing, utility trenching, excavation, delivery and storage of materials, and erection of the building.

B. In general the scope of work associated with the PAB Mechanical Chase and High Rise Upgrades is the first phase of a multi phase project to upgrade the existing PAB. This first phase includes multiple upgrades for compliance with the high rise section of the building code. Additional upgrades in this phase will provide the HVAC, plumbing electrical and fire protection infrastructure to accommodate the future phases of work that will take place on a floor by floor basis.

C. This project includes but is not limited to the following:

**Architectural/ Structural Alterations:**

a. Removal of existing precast concrete wall panels and windows **(windows to be salvage and provided to the City as directed)** to accommodate new mechanical chases on the east and west sides of the structure.
b. Selective demolition of exterior wall panels, and structural concrete to accommodate new high rise pressurization ductwork and fans.
c. General demolition required work to accommodate the mechanical chase and high rise upgrades.
d. Construction of new equipment rails for support of pressurization fans.
e. Construction of temporary partitions to separate occupied floor areas from areas that will be exposed to the elements during the construction of the mechanical chases on the east and west sides of the building.
f. New exterior wall panels and steel support framing at the proposed mechanical chases.
g. Application of spray Applied Fire Resistive materials to structural framing members that undergo asbestos abatement.
h. Interior remodeling of occupied areas affected by the mechanical chases and pipe risers.

**Electrical Alterations:**

a. The project includes electrical system modifications to separate emergency distribution into life safety, legally required and standby systems.

b. Removing the existing 8th floor generator.
c. Modifications for increased fire pump size.
d. Put in place fire alarm infrastructure to expansion of a voice based system throughout the building as floors are renovated with some of the fireman's phones installed where possible to meet high rise requirements.
e. Removal/reinstallation of electrical materials as required for the installation of exterior shafts.
f. Telecommunications modifications and additions; and new lighting for interior spaces
g. New exterior signage.

**Mechanical Alterations:**

a. New supply air riser ducts from existing penthouse air handling units, routed down exterior shafts (east and west) and capped at each floor level for future use.
b. New pressurization fans and controls for stair towers and elevator hoistways.
c. New fan coil system to condition newly created elevator equipment room in 8th floor penthouse for security elevator.
d. Five (5) new variable air volume (VAV) terminal units and controls serving various areas connected to new supply air and hot water risers.

**Fire Protection Alterations:**

a. New fire pump, jockey pump and controllers located in dedicated room to replace existing fire pump.

D. Examine Documents and Visit Site:

1. Before submitting a bid proposal, bidders should carefully examine the drawings and specifications; visit the site of work **(Contractors must schedule site visits with Project Contact)**; fully inform themselves as to all existing conditions and limitations, including those of labor; and shall include in the bid proposal a sum sufficient to cover the cost of all items contemplated by the construction documents.

2. Each sub-bidder further represents that he has inspected the site of the proposed work **(Contractors must schedule site visits with Project Contact)** to ascertain any obstacles that might be encountered and other matters and conditions relevant to this work.

3. The nature of the work required demands thorough review of all drawings and the project manual, and diligent and careful site inspection by all prospective sub-bidders as a means of determining the extent of work and conditions under which the work is to be performed.

4. Additional charges will not be as considered for work which, prior to bidding, could reasonably be inferred as appropriate by examination of the drawings and specifications, visiting the site, and closely reviewing the work as indicated above. No representations as to subsurface conditions are made.

3. WORK BY OTHERS:

Work "By Others" shall be coordinated with the "Police Administration Building New Chase and High Rise Upgrades" (PAB Chase Contract) contract to provide a seamless project schedule. Any conflict or potential delays shall be brought to the attention of the City as soon as they as discovered.

A. Removal of hazardous (Asbestos) materials is outside this contract and is to be performed by "Others".

Note: **Do not disturb hazardous materials or items suspected of containing hazardous materials. A report on the presence of hazardous materials is on file for review and use. If items are suspected of containing hazardous materials are encountered immediately notify owner. Owner will remove hazardous materials under a separate contract**

4. SCHEDULING OF WORK:

A. The contractor shall provide a construction schedule which includes all phases of construction, indicating the anticipated start and completion times for each of those phases. The contractor shall provide that complete schedule at the Pre-Construction Meeting arranged by the City.

B. All work, unless otherwise specifically approved, is to be done during normal working hours.

# SECTION 01210: PROJECT MEETINGS

1. SCOPE:

   A. Index:

      1. Scope
      2. Pre-Construction Meeting
      3. Progress Meetings

2. PRE-CONSTRUCTION MEETING:

   A. Soon after the award of the contract and prior to the start of construction, the contractor shall attend a pre-construction conference with representatives of the City.

   B. The contractor shall have at the meeting responsible representatives from subcontractors who are to perform major work on the project.

   C. The purpose of the meeting is to discuss in detail the plans and specifications. The discussion shall include:

      1. Schedule
      2. Equipment
      3. Material Storage
      4. Traffic Control
      5. Inspection Requirements
      6. Protection Procedures for the structure, adjacent facilities, environment, and personnel.
      7. Hours of Work

   D. The contractor shall submit the construction schedule to the architect/engineer at this meeting and a listing of subcontractors and their work. The contractor shall describe, in detail, when each portion of the work is expected to be accomplished. The subcontractors shall participate in the discussion. The architect/engineer will serve to interpret the contract documents should such questions arise.

   E. Any other questions that the contractor or his subcontractors have about the work or its scheduling shall be raised at these meetings.

   F. Requirements for contract administration and construction operations will be defined for participants.

   G. The architect/engineer will determine time, date, and place of the meeting.

3. PROGRESS MEETINGS:

   A. Bi-weekly meetings will be held for the purpose of coordinating and expediting the work.

   B. Attendance at project meetings by the contractor is mandatory. These meetings shall also be attended by representatives of each subcontractor who is either working at the site or is affected by work being done at the site. The contractor shall submit an updated construction schedule at these meetings and a short narrative should be written, describing the cause of any delays and intended action to remedy these delays.

C. Contractors shall give a verbal report of progress on the project, discuss the work schedule for the coming period, and present all conflicts, discrepancies, or other difficulties for resolution.

SECTION 01300: SUBMITTALS/PERMITS

1. SCOPE:

A. Index:

1. Scope
2. Submittals
3. Permits
4. Inspection

2. SUBMITTALS:

A. Comply with the requirements of the General Conditions and as follows:

1. Forward Submittals not more than 20 calendar days after the Notice to Proceed date. No work, as indicated on any shop drawing, samples, hardware list, etc., shall be started until those submittals have been reviewed and work authorized.

2. All submittals must be thoroughly reviewed by the prime contractor for conformance to contract documents, prior to submission to the City, or its agents, for review. Shop drawings and catalog information shall be stamped "Reviewed By" and signed by the contractor's reviewer. The prime contractor shall review all subcontractor submittals prior to submittal to the City for compliance with contract documents and to coordinate all work.

3. Include with each submittal a transmittal letter signed and dated by the prime contractor containing the following:

a. Name of Contractor
b. Name of Project
c. List of Submittals
d. Name of Manufacturer or Supplier
e. Additional information as required for the items being provided.

B. Shop Drawings, Catalog Information, Calculations, and Samples:

1. Shop Drawings: Submit one blue/black line print review. The City will notify the contractor in writing and return one copy marked "REVIEWED - NO EXCEPTIONS TAKEN" with minor or no notations. The City will also notify the contractor in writing and return one copy, along with comments, when the drawings are marked either "REJECTED" or "REVISE AND RESUBMIT". For those shop drawings, the contractor will be responsible for resubmitting a new print.

2. Catalog Information and Calculations: Submit four copies for City's record and additional numbers of copies required for the contractor's purpose. The City will notify the contractor in writing and return the contractor's copies, with or without notation,



marked either "REVIEWED - NO EXCEPTIONS TAKEN", "REVISE AND RESUBMIT", OR "REJECTED". Catalog information or calculations marked "REVISE AND RESUBMIT" or "REJECTED" must be resubmitted in the same quantities as originally required.

3. Samples: Submit two samples of requested materials for the City's records and

additional samples, if desired, to be returned to the contractor. The City will notify the contractor in writing, whether the samples are approved or rejected. If they are rejected, new samples must be resubmitted as originally required.

4. Corrections or comments made on the submittals during the review do not relieve the contractor from compliance with requirements of the contract documents. The check is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. Contractors are responsible for conforming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating their work with that of all other trades; and performing their work in a safe manner.

C. "Or Equal": Whenever the words "or equal" or similar term is used, it shall mean as determined by the Commissioner of Public Works or agent. All drawings, data and bulletins necessary to make an "or equal" determination shall be submitted to the Facilities Manager of Buildings & Fleet Services. Such review shall apply to design only and shall in no way relieve the contractor from the responsibilities as outlined in Item 2B above. Evaluation of "or equal" products will be made at the time of shop drawing submission. Any change required in design and coordination between all contractors, subcontractors, or trades due to the use of "or equal" materials shall become the contractor's responsibility. Any costs for detailed engineering reviews and/or any costs to incorporate "or equal" products will be borne by the contractor.

3. PERMITS:

A. The City of Milwaukee will provide the general building and occupancy permits.

B. Contractors shall obtain, from the City of Milwaukee Department of City Development and/or other government or private agencies, all special permits as may be necessary in their work.

C. Contractors shall obtain all permits to occupy or work in the public way as may be necessary for their work.

D. Contractors shall notify the City and/or appropriate utilities when making utility connections as part of the project.

4. INSPECTION:

A. Buildings & Fleet Services will provide daily inspection to verify compliance with contract documents, identify contractors and crews on the job, verify compliance with contract conditions (EBE, residency, wage requirements), and record job progress and conditions.



**B. Contractors shall arrange with the Department of Neighborhood Services/Construction Trades Division and permit issuing agencies for all code compliance inspections as required by all permits including, but not limited to, the general building and all special permits issued by that agency.**

**C. Contractors shall arrange with the appropriate City agency for compliance inspections, as required, for all permits including, but not limited to, curb and pavement cuts and patches, and public way occupancy and utility connections.**

# SECTION 01500: JOB SITE UTILITIES, FACILITIES, AND SECURITY

## 1. SCOPE:

### A. Index:


1. Scope
2. Building Security
3 Temporary or Trial Usage
4. Occupancy During Construction
5. Scaffolding
6. Electrical Power
7. Water
8. Toilet Facilities
9. Security and Weather Protection
10. Parking
11. Deliveries
12. Use of Premises & Restrictions
13. Field Office


## 2. BUILDING SECURITY:

### A. General:

The Downtown Complex is open to the public from 8:00 AM until 4:45 PM, Monday through Friday, excluding holidays. Since most contracted work takes place outside normal business hours, it is essential that contractors and their City agents understand and abide by security policy.

Outlying buildings are not generally open to the public. Contracted work in these buildings can take place at any time. It is essential that contractors and their City agents understand and abide by security policy.

### B. Police Access (General):

1. Access to Milwaukee Police Department facilities requires the contractor to meet the following access procedures.

2. The Police Department require that all contractors, vendors, visitor or other who intend to do business at any Police Department site must have a background check performed by the Milwaukee Police Department **PRIOR** to any access.

3. All contractors' staff requiring access to the site, including any subcontractors, suppliers or vendors will be required to submit their full name (including full middle name) and birth date, race and sex, to allow the Department to perform the necessary background check. The contractor shall provide a staff list two weeks before work begins. At this time contractor shall provide a brief outline of the work, project schedule, and company contact information (company name, contact name and title, phone number and address).

4. To add staff during the course of the project provide the same information as above and submit a minimum of 3 working days in advance of working on site.

5. Sign in and sign out will be required at all Milwaukee Police Department facilities.

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C. Scope:

At the beginning of any project, a copy of this policy and procedure statement will be added to the project manual for bid consideration and shall be distributed at the Pre-Construction Meeting. All City agents/officials responsible for engaging contractors, all contractors, and all subcontractors shall be held responsible for following the procedures.

D. City Agents/Officials:

1. Any City agents/officials who commission outside contractors to work in any of the facilities managed by Buildings and Fleet Services shall provide the following information no less than twenty-four (24) hours in advance of the work:

   a. The names of any contract or subcontract employees who will be present in the facilities (for the purpose of designing badges appropriate to their work area):

      Green – Zeidler Municipal Building, 841 North Broadway
      Red – City Hall, 200 East Wells Street
      Yellow – 809 North Broadway
      Gold – Any outlying buildings

      These names must be listed on a sign-in sheet available in the Zeidler Municipal Building, Room 602, DPW Facilities Dev. & Management. City shall be responsible to ensure the sheet and badges are transported to the appropriate location where the work is to be completed (City Hall Information Center for the Downtown Complex, for outlying buildings to the designated Facility Manager) before work is to begin.

   b. A list of keys and/or access cards required for access only to the areas necessary for work involved in the project. The keys and card will be received from the Security Manager or his designee and signed out to the City agents/officials responsible for the contracted work. The City employee will take the keys and/or access cards to the City Hall Information Center or the person responsible for controlling access in the outlying building where they shall be logged under the name of the contractor's company. When a project is complete, the City agents/officials must retrieve the keys/cards and return them to Buildings & Fleet Services support staff in Room 602 of the Zeidler Municipal Building.

E. Contractors:

1. Contractors shall abide by City security policy and procedures at all times during the scope of their participation in a project. Failure to comply will result in the contracted employee being escorted from the premises and the resulting lost time and expense shall be deducted from the contractor's invoice or penalties of $50.00 per occurrence as determined by the contracting City agent/official.

   a. All access should be provided in advance through the City agent/official. Contractors shall enter and exit only through those doors designated by the City (the Market Street entrance to City Hall and the doors established by the person responsible for access at outlying buildings). All other exterior doors are locked and alarmed and are not to be used as delivery points unless the

City agent/official has been provided 24 hour notification to provide additional security coverage at that point while the delivery is in progress.

b. All of the contractor's employees and all of the employees of any of his subcontractors shall wear at all times while on the site, in a clearly visible location, an identification card. The identification card is to have a minimum 1" x 1" color photo of the head and shoulders. The photo is to have been taken no more than one year previously. The card is to be laminated with clear plastic and is to contain the company name, employee's name, and the employee's signature, and is to be furnished by the contractor or respective subcontractor.

F. Key or Key Card Access: **Effective October 1, 2004 -** The following policy has been established to maintain control of City Property and to ensure the physical protection of the City Hall Complex. signing out access cards and/or keys from the Information Center will be following the steps below.

1) Sign in on the sheet assigned to the project you are working on and pull that sheet and provide it to the Operator noting that you will need to sign out City property to access the building.

2) Provide the Operator your driver's license as collateral for the return of City property.

3) Sign out the property in the sign out book as per current policy.

4) The Operator will file your driver's license until such time as you sign in and return the City property at which time your license will be returned.

5) Sign out at the end of your workday on the sign out sheet.

6) Under NO circumstances will keys or cards be disbursed without the user signing for the property and providing the City Hall Operator their driver's license as collateral.

7) In the event that keys or cards are not returned daily the contractor in question will have a deduct (security violation) **$50.00** penalty for each occurrence.as per the contract. Individuals who loose or fail to return keys will be responsible for the cost of re-keying to the City.

8) Contractors shall not ask custodians or mechanics to unlock doors. In the rare case where access is not provided, the City Hall Operator may be contacted to assist in providing access. The contractor should be prepared to allow searches of equipment when leaving, and should remain only in the areas designated on the sign-in sheets.

G. Outlying Building Access:

1) If after normal business hours work is required in the outlying buildings, all subcontractors and trades will arrange appropriate security measures and lock-up procedures with the contractor in writing. Any work completed at night shall be left "open" for City inspection of the work. The contractor shall notify the City agent/official 24 hours in advance of after-hours work in writing, indicating the type of work to be

done and the security measures to be taken by the contractor.

2) The contractor shall provide plywood door and window closures during construction to secure the structure from weather and damage from vandalism. The contractor is responsible to maintain the security of the space where they are working during construction.

3) If proper notification is not provided to the contractor, the subcontractor or trades shall be liable for any subsequent damage/vandalism/inspection cost, etc., due to lack of security/inspection coordination.

4) Use of City materials is strictly prohibited unless pre-arranged through the City employee contact.

5) At no time shall any interior doors that control access or exterior doors be propped open.

3 TEMPORARY OR TRIAL USAGE:

The owner shall have the right to make temporary or trial usage of any mechanical device, machinery, apparatus, equipment, work, material or construction supplied under contract before final completion or acceptance of the work, and the same shall not be construed as evidence of acceptance of the work by the owner.

4. OCCUPANCY DURING CONSTRUCTION:

A. Owner Occupancy: Owner will occupy the 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 operations.

A. Maintain access to existing walkways, corridors, and other areas adjacent to the contract limits. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.

B. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

5. SCAFFOLDING:

General Contractor shall provide protective sidewalk scaffolding and any additional measures as required to protect the public and allow safe use of this entrance into the facility during the entire construction period.

All scaffolding, swing stages and lifts as required to perform work defined in this contract document shall be provided and maintained by the General Contractor and shall be removed when no longer needed. The General Contractor is solely responsible for the design, safety and security of any scaffolding erected under this contract for this project. All scaffolding, swing stages and lifts shall be available with operators for access to the project for the Project Engineer, City Liaison and City Inspectors.

Exterior scaffolding access (up & down) shall be provided. Access through to the facility will be strictly limited. Adequate security must be provided by the General Contractor to limit the opportunity of

unauthorized access of scaffolding.

Submittals for the scaffolding and egress protection shall be provided and reviewed before proceeding with erection. Scaffolding and egress protection submittals shall be stamped by a professional engineer. The scaffolding engineer shall design any foundations or anchoring points as required. The scaffolding system shall be properly grounded.

All anchors and other attachments into building shall be limited. All anchors and attachment shall be clearly indicated on submittals. All costs for scaffolding including installation of anchoring, foundation, erection and patching of all anchor and attachment points at the conclusion of the project shall be included in the base bid. Patching of all anchor or attachment points shall match existing façade materials. On site patching sample shall be provided and approved before proceeding with all patch work. Any damage to sidewalks, pavement or landscaped areas shall be restored to existing pre-construction conditions after the removal of the scaffolding.

Swing stages shall be installed and operated in accordance with all OSHA requirements.

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6. ELECTRICAL POWER:

Contractor may use existing outlets for power. Contractor is to supply his own lines. OSHA regulations require that employers use either ground fault circuit interrupters or an assured equipment grounding conductor program in addition to any other regulations for equipment grounding conductors. The cost of the current used will be paid for by the City.

7. WATER:

Contractor may use existing hose bibs for water. Contractor is to supply his own hoses. Contractor's hoses shall be leak free and contractor is to regulate the flow to limit it to project related use. The cost of the water will be paid for by the City.

8. TOILET FACILITIES:

Contractor to provide and maintain temporary/portable toilets facilities for duration of construction.

9. SECURITY AND WEATHER PROTECTION:

A. Contractor is to maintain existing building in a weather-tight condition throughout construction period and repair damage caused by construction operations. Protect building and its occupants during construction period.

B. Contractor to protect building and its occupants during construction period. Contractor is to furnish, install, and maintain acceptable security at any opening required by construction to the exterior of the building until construction at opening is complete.

C. Any measures installed shall be suitable to maintain building security after work hours.

10. PARKING:

There is no parking available on the proposed site outside of the contract limits. Contractor is responsible for parking of vehicles. No additional parking areas will be provided by the City.

11. DELIVERIES:

A. Schedule bulk material deliveries between the hours of 6 p.m. and 6 a.m.

B. Bulk materials may be delivered thru the garage and via the elevators. Use of the elevators for transfer of materials shall require 48 hour advance notification to the owner and should be restricted to the freight elevator.

C. Contractors dumpster may be located on the west side of the building

D. There are no storage locations within the building. All materials must be stored within the contract limits shown on the drawings.

E. Contractor is responsible for the receiving of all deliveries associated with the project and the moving of those items to the proper storage location. Deliveries will not be allowed to sit on the loading dock unattended.

F. There is no parking available on the proposed site outside of the contract limits.

G. Dock Access: 24 hour advance notice shall be given to the City agent/official to provide arrangements for access and verify building security arrangements for the delivery. The contractor or subcontractor shall meet the delivery driver and take delivery at that point. At no time shall a driver be allowed in the facilities without following the access procedure stated above.

12. USE OF PREMISES & RESTRICTIONS:

In general Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits. Use of Site is limited to areas within the Contract Limits indicated. Contractor is required to submit proposed dumpster storage locations and proposed truck loading and unloading location to owner for approval.

A. On-Site Work Hours: Work shall be generally performed inside the existing building during normal business working hours of 7 a.m. to 6 p.m., Monday through Friday, unless agreed to otherwise by owner.

B. Note that the building is occupied 24/7 year long. All work is to be coordinated and approved to avoid conflict with Police Department's operations at all times including work to be performed outside of "normal business hours".

C. Work that is potentially disruptive to the owner is required to take place between the hours of 5 p.m. to 7 a.m, or on Saturday or Sunday, and requires prior notification to the owner. This work includes but is not limited to the following items:

1. Crane lifts of construction and demolition materials that occur above sky-bridges, enclosed walkways and other similar spaces that are normally occupied during regular business hours.

2. Floor coring or cutting.

3. Installation of Mechanical and Electrical components located above the ceilings of areas that will be occupied during construction.

4. Demolition of existing partitions.

5. Any work that will produce a noise volume that would prevent a normal telephone conversation from occurring adjacent to the work being performed or that will transmit noise or vibration throughout the structure of the building.

D. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Owner not less than 7 calendar days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Owner's permission.

E. Prisoner Detention Areas: A preconstruction meeting shall be held with the Milwaukee Police Department prior to the commencement of the project to discuss alteration work in the Prisoner Detention areas. This will include but not be limited to the following items

A. Notification requirements needed prior to commencement of demolition and construction work.

B. Time restrictions for construction work.

C. Access thru prisoner detention areas adjacent to construction work including use of the prisoner elevator.

## 13 Field Office:

Contractor shall provide a suitable Field Office for Contractor's staff, subcontractors and City Project Inspector to coordinate project. The Office shall have a dedicated plan table for the Contractor's project plans and record drawings for coordination of this project. This Field Office shall have an assigned area with plan table for City Project Inspector.

SECTION 01505: CONSTRUCTION WASTE MANAGEMENT

**PART 2 - GENERAL**

1.1 SCOPE:

A. This section specifies requirements for salvaging, recycling and disposing of construction waste for purposes of protecting the environment and reducing project cost.

Requirements include the following:

A. Developing a Construction Waste Management Plan including waste management goals and provisions for waste reduction and recycling.
B. Implementing, monitoring and documenting the waste management plan.
C. Incorporating special programs.
D. Evaluating construction waste management.

1.2 RELATED DOCUMENTS AND SECTIONS:

A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

B. Related documents include the following

A. Section 01010 “Summary of Work”
B. Section 01300 “Submittal & Permits”
C. Section 001500 “Utilities, Facilities, and Security” for environmental-protection measures during construction.
D. Section 01735 “Selective Demolition” for disposition of waste resulting from partial demolition of buildings, structures, and site improvements **[and for disposition of hazardous waste].**

1.3 PRECONSTRUCTION MEETING:

A. After award of Contract and prior to the commencement of the Work, schedule and conduct a meeting with the Owner and Architect to discuss the proposed Construction Waste Management Plan and to develop a mutual understanding regarding details of environmental protection.

1.4 CONSTRUCTION WASTE MANAGEMENT PLAN:

A. Construction Waste Management Plan

A. The purpose of the Construction Waste Management Plan is to identify construction waste reduction goals, identify targeted materials, and explain specific waste reduction actions to be taken, by whom, and when.
B. The Contractor shall develop a Construction Waste Management Plan for this Project within 15 working days after Contract award or prior to any waste removal. The Owner and the Architect will furnish the Contractor with information that will assist in the development of the Construction Waste Management Plan. Submit the Construction Waste Management Plan (include document/report form) to the Architect for approval prior to implementing the Plan.

B. Progress Documentation: Document solid waste disposal and diversion. Include the date of removal, type of waste removed, quantity by weight and volume, final destination and use (recycled, reused or landfilled), and net cost or income.

A. Document on the Form form acceptable to the Owner and Architect.

B. With each Application for Payment, submit updated documentation identifying solid waste disposal and diversion.

C. With each Application for Payment, submit manifests, weight tickets, receipts and invoices identifying the Project and construction waste material.

C. Record Submittals: Submit the following:

A. Summary of solid waste disposal and diversion. Submit on form acceptable to the Owner and Architect.

B. End-of-Project recycling rates and landfill rates demonstrating the percentage of construction waste that was recycled or reused.

1.5 WASTE MANAGEMENT GOALS:

A. Develop Construction Waste Management Plan that results in end-of-Project rates for the reuse/recycling of **50%** percent by weight or volume of total waste generated by the Project. Record the total construction waste reduction goal on the Construction Waste Management Plan Form.

B. Reduce: The Project shall generate the least amount of waste and methods shall be used that minimize waste due to error, poor planning, breakage, mishandling, contamination, or similar factors. Promote the resourceful use of materials to the greatest extent possible.

C. Reuse: The Contractor and Subcontractors shall reuse materials to the greatest extent possible. Reuse includes the following:

A. Salvage reusable materials for resale, for reuse on this Project, or for storage for use on future projects.

B. Return reusable items (e.g., pallets or unused products) to the material suppliers.

D. Recycle: As many of the waste materials not able to be eliminated in the first place or salvaged for reuse shall be recycled. Waste disposal in landfills shall be minimized to greatest extent possible.

1.6 MATERIALS HANDLING AND SORTING:

A. Handling:

A. Materials that are contaminated prior to placing in collection containers shall be properly cleaned. Deliver materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling processes.

B. Cover materials with tarps and keep truckloads level so as to prevent spillage.

C. Arrange for collection by or delivery to the appropriate recycling or reuse facility.

D. Hazardous Waste and Hazardous Materials: Handle in accordance with applicable regulations. If encountered, such waste and materials shall be abated under separate contract.

B. The following sorting methods are acceptable:

A. Sorting recyclable materials at the Project site and transporting them to recycling markets directly from the Project site.

B. Employing haulers who make use of a materials-recovery facility or a transfer station where recyclable materials are sorted from the waste and recycled before disposing of the remainder.

If using a hauler or recycling facility to sort out recyclables, verify that the hauler sorts out all construction waste loads and is not limited to those that are not acceptable at the landfill. Also, verify that the hauler or recycling facility recycles at least three types of materials.

1.11 WASTE MANAGEMENT PLAN IMPLEMENTATION:

A. The Contractor shall designate a party (or parties) who shall be responsible for instructing construction personnel and overseeing and documenting results of the Construction Waste Management Plan.

B. Distribution: The Contractor shall distribute copies of the Construction Waste Management Plan to the Project Foreman, each Subcontractor, the Owner, and the Architect.

C. Instruction: The Contractor shall provide on-site instruction regarding appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all construction personnel at the appropriate phases of the Project.

D. Separation Facilities: The Contractor shall lay out and identify a specific area on the Project site to facilitate separation of materials for recycling, salvage, reuse, and return. Recycling and waste bin areas shall be kept neat and clean, and clearly marked to avoid contamination of materials. Materials for recycling include concrete, non-fibrous wallboard, paper, clean corrugated cardboard (no pizza boxes), non-treated wood, metals (steel, aluminum and copper), and glass bottles (no windows). Provide separate containers, preferably near the job trailer, with smaller containers located at convenient places throughout the job site. Empty smaller containers into larger containers every night or when full. Cover outdoor containers to keep out rain, snow, and wind-driven debris. Lock containers whenever site is not in use to prevent illegal dumping.

E. Hazardous Waste: Hazardous waste shall be separated, stored, and disposed of according to applicable regulations.

F. Application for Payments: With each Application for Payment, the Contractor shall submit a Summary of Waste generated by the Project. Failure to submit this information shall render the Application for Payment void, thereby delaying the Progress Payment. The Summary of Waste shall contain the following information:

   A. The amount (in tons and/or cubic yards) of material landfilled from the Project, the identity of the landfill, and the related disposal cost. Include corresponding manifests, weight tickets, receipts, and invoices.

   B. For each material recycled from the Project, the amount (in tons and/or cubic yards), the date removed from the Project site, the receiving party, the transportation cost, the amount of any money paid or received for the recycled or salvaged material, and the net total cost or savings of recycling. Include corresponding manifests, weight tickets, receipts, and invoices.

G. Implementing the Plan: The Contractor shall designate a party (or parties) responsible for implementing the Construction Waste Management Plan. This party (or parties) shall explain to Contractor's and Subcontractor's construction personnel, the Plan's goals and methods for achieving those goals.

1.12 SPECIAL PROGRAMS:

A. The Contractor shall be responsible for final implementation of programs involving tax credits, rebates, or similar incentives related to recycling, if applicable to the Project. Revenues or other savings obtained for recycling or returns shall accrue to the Contractor.

B. The Contractor shall be responsible for obtaining information packets related to the special programs prior to commencing Work.

C. The Contractor shall document work methods, recycled materials, etc., as required for the tax credits, rebates, or other savings described above.

**END OF SECTION**

# SECTION 01600: MATERIALS AND EQUIPMENT

1. SCOPE:

   A. Index:

      1. Scope
      2. Materials
      3. Equipment
      4. Hazardous Material Requirements
      5. Material Storage
      6. Protection
      7. Revisions

2. MATERIALS:

   A. Furnish materials of the type, qualities, and characteristics specified. The specification of a trade name and catalog number is intended to establish quality, type, character, and operating characteristics of the material required. Materials by other manufacturers of equal specifications will be accepted, excepting as may be specifically stated otherwise.

   B. Materials shall be delivered adequately protected, in merchantable condition, and in original unbroken packages if normally packaged. They shall be stored and handled so as to protect and maintain their merchantable condition.

   C. The Commissioner of Public Works or his representative shall have the right to reject material not in compliance with the project manual, as well as damaged material, and the contractor shall remove such material from the construction site when and as directed.

3. EQUIPMENT:

   A. Internal combustion engine and compressor shall be equipped with mufflers to reduce noise to a minimum and shall not be operated in enclosed areas without adequate ventilation.

   B. All materials and work procedures used shall be in accordance with all air pollution control regulations in effect at the work site.

4. HAZARDOUS MATERIAL REQUIREMENTS:

   A. The requirements set forth in the OSHA Hazard Communication Standard, 29CFR19101.1200, U.S. Environmental Protection Agency (EPA), and Wisconsin Department of Natural Resources in the Wisconsin Administrative Code NR600, shall be met by each on-site contractor.

      1. Material Safety Data Sheets (M.S.D.S.):

         a. All contractors, which may/may not include the City of Milwaukee, shall provide the M.S.D.S. for all hazardous chemicals to which any person may be exposed at the work site.

         b. A master list will be kept in the office of the Project Supervisor/Construction Manager and updated as materials are delivered.

      2. Container Labeling:

a. Each container of hazardous material at the work site shall be clearly labeled with:

(1) Identity of the hazardous chemical(s).

(2) Appropriate hazard warning(s).

(3) Name and address of the manufacturer.

B. The City of Milwaukee reserves the right to stop the work of a contractor if compliance with OSHA regulations is inadequate. Work will not proceed until all applicable safety and health procedures are implemented by the contractor.

5. MATERIAL STORAGE:

A. The storage areas shall be kept in good order and free of all rubbish and debris.

B. Coordinate the delivery and storage of all materials and equipment with the Buildings & Fleet Services Project Inspector.

C. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

D. Store and protect products in accordance with manufacturers' instructions.

E. Store with seals and labels intact and legible.

F. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

G. For exterior storage of fabricated products, place on sloped supports above ground.

H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

I. Prevent contact with material that may cause corrosion, discoloration, or staining.

J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

6. PROTECTION:

A. The premises and the work shall be adequately protected from damage from the commencement of work to the date of final acceptance.

B. All construction work and traffic shall remain within the construction area.

C. All damage shall be corrected or repaired by the contractor or contractors causing same at his or their own expense.

D. All open pipes, pipe threads, fittings, and insulation must be protected during construction.

7. REVISIONS:

The right is reserved to make modifications to a reasonable extent as building conditions may require, or as may be required to conform to code rulings, or manufacturer's standards without extra cost to the City.

# SECTION 01700: CLEANING AND PROJECT CLOSE-OUT

1. SCOPE:

   A. Index:


   1. Scope
   2. General
   3. Safety Cleaning
   4. Progress Cleaning
   5. Disposal
   6. Final Cleaning
   7. Charges
   8. Record Drawings
   9. Operating Instructions and Maintenance Manuals
   10. Guarantees


2. GENERAL:

   Article 2.5.4 of the General Requirements of City of Milwaukee Department of Public Works shall be supplemented as specified hereinafter.

3. SAFETY CLEANING:

   Safety cleaning: Each contractor is responsible for safety cleaning, which includes but is not limited to the following:

   A. Keep work areas, passageways, ramps, stairs, free of debris and scrap.

   B. Form and scrap lumber shall have nails withdrawn or bent over and lumber shall be stacked or removed.

   C. Remove spills of oil, grease, or other liquids immediately or sprinkle with sand.

   D. Hazardous material shall be handled in accordance with Section 01600. Each container of hazardous material at the work site shall be clearly labeled with:

      a. Identity of the hazardous chemical(s).

      b. Appropriate hazard warning(s).

4. PROGRESS CLEANING:

   A. Prime Contractor and subcontractor shall remove his rubbish and debris from building site promptly upon its accumulation, and prior to the contractor's regular Friday general clean up. Contractor shall perform broom cleaning of all appropriate surfaces each Friday afternoon.

   B. Combustible waste shall be stored in fire resistive containers and disposed of regularly.

   C. Oily, flammable or hazardous wastes such as caustics, acids, harmful dusts, etc., shall be stored in appropriate covered containers.

5. DISPOSAL:

A. No burning of rubbish or debris will be allowed at site. No rubbish shall be thrown through opening or from heights without proper protection. Where dust will be generated or flying debris is likely to occur, provide dust tight chutes or other means to control dust.

B. Containers: Contractor shall provide mobile industrial type waste containers in the number and size required, placed at adequate locations to handle debris or provide other methods of disposing of debris.

C. Oil, flammable or hazardous wastes such as, but not limited to, caustics, acids, harmful dusts, etc., shall be placed in properly marked containers as necessary and disposed of at a site designed for such wastes.

6. FINAL CLEANING:

A. Immediately prior to substantial completion.

B. Contractors shall expedite or perform thorough cleaning, sweeping, washing and polishing of work to remove from work and equipment provided under his contract, all foreign matter, spots and soil, so as to put all such work and equipment, including finishes, in a complete and finished condition ready for acceptance and use intended.

C. The contractor is responsible for final sweeping and dusting not covered by other subcontractors. This general cleaning shall include all areas and floors of the building, including the site outside the building.

7. CHARGES:

A. If prime contractors do not remove rubbish or clean building as specified above, owner reserves right to have work done by others at contractor's expense.

B. Employees of the owner who are required to clean up any rubbish or to sweep any floors will record all hours involved to complete such work. The cost incurred by the owner for this special cleaning and sweep-up work shall be charged against the contract price of the contractor as determined by owner.

8. RECORD DRAWINGS:

A. At the completion of work and prior to final payment, the mechanical and electrical contractors shall provide Buildings & Fleet Services with three (3) marked up sets of prints showing all changes or variations from contract drawings, and not specified on change order drawings theretofore issued. Contractors providing buried or concealed piping, conduit, or similar items shall locate such items by dimensions and elevations.

B. Other contractors shall provide one (1) marked up set of prints showing all changes or variations from contract drawings.

C. Drawings shall show complete layout of revised piping, equipment, etc., as actually installed.

9. OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS:

A. The contractor shall, upon completion of all work, furnish the necessary skilled labor to instruct City personnel in the operation, adjustment, and maintenance of all equipment furnished.

B. At termination of work, the contractor shall submit maintenance and operating manuals presenting full details of care and maintenance and operation of mechanical and electrical equipment of every nature. See specific requirements in relevant sections as applicable.

C. The manual shall include manufacturer's instructions for maintenance and operation and shall be completely indexed, including the spare parts list. See specific requirements in relevant sections.

D. Submit three (3) final copies in hard bound cover to Buildings & Fleet Services.

E. The contractor shall allow for a four (4) hour training session for City maintenance personnel on all equipment and controls installed under this contract.

10. GUARANTEES:

A. Each contractor shall guarantee to replace or repair promptly at his own expense, as directed by the Commissioner of Public Works or his agent, all workmanship or materials in which defects may develop within one (1) year from the date of final acceptance of his work. This guarantee includes all damage done to the City due to faulty equipment, poor installation or poor construction.

B. Guarantee periods other than the one year time period are indicated in specific specification sections.

## SECTION 024119 - SELECTIVE STRUCTURE DEMOLITION

## 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. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

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: Detach items from existing construction and deliver them to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Locations of proposed dust- and noise-control temporary partitions and means of egress.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
6. Means of protection for items to remain and items in path of waste removal from building.

B. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

C. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations.

## 1.5 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241.

D. Pre-demolition Conference: Conduct conference at Project site to comply with requirements in Division 01. Review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

## 1.6 PROJECT CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials are present in the building. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
1. Hazardous material remediation in this building is being executed under a separate contract by the City of Milwaukee DPW.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

D. 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.

E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs.

G. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.

2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

    a. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

## 3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 01 Section "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

## 3.4 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. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
4. Maintain adequate ventilation when using cutting torches.
5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
6. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
7. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
8. Dispose of demolished items and materials promptly.

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. 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 cleaned and reinstalled in their original locations after selective demolition operations are complete.

## 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Structural Concrete:
1. Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
2. Ensure that all temporary shoring or permanent structural supports are installed prior to demolition.

B. Precast Concrete Wall Panels:
1. Remove entire wall panels without breaking into smaller pieces.
2. Removal of panels shall take place between the hours of 4pm and 7am

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

D. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.

1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.

## 3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

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.
4. Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

## 3.7 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.

END OF SECTION 024119

## SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture.

C. Shop Drawings: For steel reinforcement. Material test reports.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

C. Preinstallation Conference: Conduct conference at Project site.

## PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

## 2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
   1. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

D. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from galvanized steel wire into flat sheets.

E. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

## 2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

   1. Portland Cement: ASTM C 150, Type I. Supplement with the following:

      a. Fly Ash: ASTM C 618, Class C.
      b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

   2. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag or Type I (SM), slag-modified portland cement.

B. Normal-Weight Aggregates: ASTM C 33, graded, 3/4-inch nominal maximum coarse-aggregate size.

   1. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

F. Synthetic Fiber: Macro-synthetic fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1 ½" to 2 ½" inches long.

## 2.4 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

## 2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

## 2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

## 2.7 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Miscellaneous Concrete: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 3 inches, plus or minus 1 inch.

4. Aggregate: Maximum 3/4-inch nominal maximum aggregate size.
5. Air Content: None.

2.8 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

**PART 3 - EXECUTION**

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork according to ACI 301 to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR RETARDERS

A. Vapor retarder is part of the methane containment system designed and specified by the design-build plumbing contractor.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

## 3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

## 3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

C. Cold-Weather Placement: Comply with ACI 306.1.

D. Hot-Weather Placement: Comply with ACI 301.

## 3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

## 3.8 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.

1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated or where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

## 3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period. Use TK Archo Seal or approved equal.

3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

**END OF SECTION 03 30 00**

**SECTION 034510- PRECAST CONCRETE WALL PANELS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following: Precast Concrete Wall Panels consisting of cold formed metal framing, a 2-inch thick reinforced concrete facing or topping on one side, with a metal connector providing a shear-flow connection between the cold formed metal framing and the concrete. Work under this section shall include installation of the composite precast concrete wall panels including all panel to panel connections, all connections to the superstructure and installation of elastomeric sealants at all joints.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide panels, including panel frames, anchors, and connections, capable of withstanding the following design loads, as well as the effects of thermal- and moisture-induced volume changes, according to load factors and combinations established in PCI Design Manuals.
   1. Design Loads: in accordance the requirements of the "Design Table" on drawing S100.
   2. Deflection: Design panel frames to withstand design loads without lateral deflections greater than 1/240 of wall span.
   3. Thermal Movements: Provide for thermal movements resulting from annual ambient temperature changes of 100 degF (56 degC).
   4. Design panel frames and connections to accommodate deflections and other building movements.
   5. Design panel frames to withstand dead loads of adjacent panels where indicated on drawings
   6. Design panel frames to support dead load of building signage.

1.4 SUBMITTALS

A. Product Data of each type of product used in panel assembly.

B. Design Mixes: for each concrete mixture. Include compressive strength and water absorption tests.

C. Samples:
   1. Submit initial samples for verification, approximately 12" x 12", representative of finished exposed face.
   2. Submit final samples for approval approximately 12"x 12".

D. Shop and Erection Drawings:
   1. Material specifications
   2. Floor plan identifying location of panels.
   3. Floor plan identifying location of pre-erection attachments) to support structure.
   4. Elevations identifying location of panels and their connections.

5. Details as necessary to describe relationship of panels to adjacent material.
6. Details of panel connections.
8. Elevations and sections of typical panels showing:
   a. Geometry and finish
   b. Thickness of face
   c. Reinforcement material and layout
   d. Lifting and erection hardware sizes and locations
9. Comprehensive engineering analysis and calculations signed and sealed by the qualified professional engineer, licensed in the State of Wisconsin, responsible for its preparation.

1.5 QUALITY ASSURANCE

Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast structural concrete units similar to those indicated for this Project and with a record of successful in-service performance:

7. Regularly engaged for at least five (5) years in fabrication of precast concrete wall panels similar to those required on this project.
8. Assumes responsibility for engineering precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
9. Participates in PCI's Plant Certification program and is designated a PCI-certified plant.

B. Installer Qualifications: Regularly engaged for at least five (5) years in installation of precast concrete wall panels similar to those required on this project.

C. Mock Up:
   1. After standard samples are accepted for color and texture, produce one full-scale panel a minimum of 4-feet x 8-feet, meeting design requirements. This panel shall be viewed and approved by the owner and architect at the project location. Approval of mock-up panel is required prior to production of panels for this project
   2. The full-scale panel shall be representative of standard quality for precast panel work, when accepted by Architect

D. Design Standards: Comply with ACI 318 and the design recommendations of PCI MNL 120 “PCI Design Handbook- Precast and Pre-stressed Concrete” applicable to the wall panels on this project.

E. Quality Control Standard: for manufacturing procedures and testing requirements, quality control recommendations , and dimensional tolerances for types of units required, comply with PCI MNL 117, “Manual for Quality Control for Plants and production of Precast Concrete Products”

F. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
   1 Regularly engaged for at least five (5) years in fabrication of precast panels wall panels similar to those required on this project.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, staining, and to prevent cracking, distortion, warping or other physical damage.

B. Store units, unless otherwise specified, with non-staining, resilient supports.

C. Place stored units so identification marks are clearly visible and product can be inspected.

D. Deliver all Panels to the project site in such quantities and at such times to assure compliance with the agreed project schedule and proper setting sequence so as to limit unloading units temporarily on the ground.

E. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.

F. Lift and support units only at designated points shown on the Shop Drawings.

G. Place non-staining resilient spacers of even thickness between each unit.

H. Support units during shipment on non-staining shock absorbing material.

## PRODUCTS

### 2.1 FABRICATORS

A. Available Fabricators: Subject to compliance with requirements of this Section.

### 2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; non-reactive with concrete and suitable for producing required finishes.

B. Form Liners: Units of face design, texture, arrangement, and configuration to match precast concrete design reference sample. Provide solid backing and form supports to ensure that form liners remain in place during concrete placement. Use with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

C. Surface Retarder: Chemical set retarder capable of temporarily delaying hardening of newly placed concrete mix to depth of reveal specified.

### 2.3 REINFORCING MATERIALS

A. Reinforcing Bars - Steel Reinforcement: ASTM A 615/A 615M, Grade 60 (Grade 420), galvanized or epoxy coated, deformed except where plain bars are indicated.

B. Plain Steel Welded Wire Reinforcement: ASTM A 185, fabricated from galvanized and chromate wash, treated steel wire into flat sheets. Triple coated, hot-dipped galvanized, 3.6 Mils

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet fabricated from galvanized and chromate wash, treated steel wire into flat sheets. Triple coated, hot-dipped galvanized, 3.6 Mils.

D. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117. Use epoxy coated, annealed type tie wire, 16.5 gauge or heavier.

### 2.4 METAL FRAMING MATERIALS

A. General: Provide all steel framing members with ASTM A 525 G-90 galvanized coating, unless otherwise indicated.

B. Cold Formed Metal Framing:

1. Stud Framing Members shall be as follows: minimum 16 Gauge formed from steel that corresponds to requirements of ASTM A 570-50, with a minimum yield of 50,000 psi or as established in Table 1 of ICBO ER-5446 whichever is greater.

2. Track, Bridging, and Accessories: 14 Gauge galvanized formed steel members.

3. Bent Plates: HR1020 (35,000 psi yield-strength) conforming to AISI requirements
4. Provide welded stud connectors with thermal break non-corrosive coating.
5. Screws: Screws shall be galvanized tek type self-drilling, self-tapping sheet metal screws of a manufacturer or brand recognized in a current ICBO ES report. The screws must comply with the standards for the allowable pullout and shear loads described in those reports. The design engineer shall calculate the shear, pullout and tension requirements and select a screw that has confirmed the capacity for those values.

## 2.5 CONCRETE MATERIALS

A. Portland Cement: ASTM C150, Type I, II or III.

B. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S. Provide and stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for entire project.

C. Backup Concrete Aggregates: ASTM C33 or C330.

D. Integral water repellent admixture.

E. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable and non-fading.

F. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

G. Air Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures, with not more than 0.1% of soluble chloride ions by weight of cement.

H. Water-Reducing Admixture: ASTM C 494/C494M, Type A, if required.

I. Retarding Admixture: ASTM C 494/C494M, Type B, if required.

J. Water-Reducing and Retarding Admixture: ASTM C 494/C494M, Type D, if required.

K. High-Range, Water-Reducing Admixture: ASTM C 494/C494M, Type F, if required.

L. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C494M, Type G, if required.

M. Plasticizing Admixture for Flowable Concrete: ASTM C 1017/C1017M, if required.

N. Admixtures containing calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture are not permitted.

## 2.6 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M except silicon (Si) content in the range of 0 to 0.03% or 0.15 to 0.25% for materials to be galvanized. Steel with chemistry conforming to the formula $Si + 2.5P < 0.09$ is also acceptable.

B. Stainless-Steel Headed Studs: ASTM A 276, Proprietary grade, cold finished; AWS D1.1, with arc shields.

C. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.

D. Deformed Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M, if required.

E. Carbon Steel Bolts and Studs: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6) carbon-steel, hex-head bolts and studs; carbon steel nuts (ASTM A563/A563M, Grade A); and flat, unhardened steel washers (ASTM F844), if required.

F. High Strength Bolts and Nuts: ASTM A 325/A 325M or ASTM A490/A490M, Type 1, heavy hex steel structural bolts, heavy hex carbon steel nuts, (ASTM A563/A563M) and hardened carbon steel washers (ASTM F436/F436M), if required for steel framing connections.

G. Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M, after fabrication, and/or ASTM A 153/A 153M, as applicable and/or electro-deposition according to ASTM B 633, SC 3, Type 1 and 2.

H. Shop Primed Finish: Prepare surfaces of non-galvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 1 followed by SSPC-SP 3 and shop-apply SSPC-Paint 25 according to SSPC-PA 1.

I. Welding Electrodes: Comply with AWS standards.

## 2.8 CONCRETE MIXES

A. Prepare design mixes to match existing exterior marble clad column enclosures.

B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at fabricator's option.

C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.

D. Normal-Weight Concrete Face and Backup Mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1 and or ACI 301, with materials to be used on project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

G. Mix Adjustments: Provided that no additional expense to the owner is involved, the fabricator may submit for architect's approval requests for adjustment to approved concrete mixes when circumstances such as availability of materials, weather, or unfavorable test results occur. Include laboratory test data substantiating performance characteristics with mix adjustment requests.

H. Integral water repellent admixture.

I. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

## 2.9 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete placement and vibration operations and temperature changes. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement by release agent. Rust on form surfaces is acceptable.

B. Maintain molds to provide completed units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

## 2.10 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement. Do not relocate without the architects prior approval.

1. Weld headed studs and deformed bar anchors used for anchorage according to AWS D1.1 and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.

C. Cast in reglets, slots, holes, and other accessories in the units as indicated on contract drawing.

D. Cast in openings larger than 10 inches (250 mm) in any dimension. Smaller openings may be field cut as required with prior approval of Architect.

E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabrication, placing, and supporting reinforcement.

F. Metal Stud Framing: Accurately position metal framing backup and anchorages and secure to form work. Locate anchorages where they will not affect the position of reinforcement or the placing of concrete.

G. Reinforce units to resist handling, transportation, and erection stresses.

H. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.

I. Place concrete to a minimum thickness after consolidation of 1 inch (25 mm), but not less than the minimum reinforcing cover as indicated on contract drawings.

J. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in units. Comply with requirements in ACI 304 and/or PCI MNL 117 for measuring, mixing, transporting, and placing concrete.

K. Thoroughly consolidate placed concrete by internal and/or external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing or entrapped air on surfaces. Provide as-cast or float finishes for surfaces which are concealed. Use equipment and procedures complying with PCI MNL 117.

L. Comply with ACI 306.1 procedures for cold-weather concrete placement.

M. Comply with ACI 305R recommendations for hot-weather concrete placement.

N. Identify pickup points of units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each unit on a surface that will not show in finished structure.

O. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until the compressive strength is high enough to ensure that stripping does not have an effect on the performance or appearance of the final product.

P. Repair damaged units to meet acceptability requirements of PCI MNL 117.

## 2.11 FABRICATION TOLERANCES

A. Fabricate Precast Wall Panels straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

B. Fabricate Panels straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with the following product tolerances.

1. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:
   a. 10 feet (3 m) or under, Plus or Minus 1/8 inch (3 mm).
   b. 10 to 20 feet (3 to 6 m), Plus 1/8 inch (3 mm), Minus 3/16 inch (5 mm).
   d. Each additional 10 feet (3 m), Plus or Minus 1/16 inch (1.5 mm).
2. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:
   a. 10 feet (3 m) or under, Plus or Minus 1/4 inch (6 mm).

b. 10 to 20 feet (3 to 6 m), Plus 1⁄4 inch (6 mm), Minus 3/8 inch (10 mm).

d. Each additional 10 feet (3 m), Plus or Minus 1/8 inch (3 mm).

3. Total Thickness or Flange Thickness: Plus 1⁄4 inch (6 mm), Minus 1/8 inch (3 mm).

7. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or Minus 1/8 inch per 72 inches (3 mm per 2 m) or 1/2 inch (13 mm)

13. Bowing: Plus or Minus L/360, maximum 1 inch (25 mm).

14. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).

15. Warping: 1/16 inch per 12 inches (1.5 mm per 300 mm) of distance from the nearest adjacent corner.

16. Tipping and Flushness of Plates: Plus or Minus 1/4 inch (6 mm).

C. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.

1. Weld Plates: Plus or Minus 1 inch (25 mm).

2. Inserts: Plus or Minus 1/2 inch (13 mm).

3. Handling Devices: Plus or Minus 3 inches (75 mm).

4. Reinforcing Steel and Welded Wire Reinforcement: Plus or Minus 1/4 inch (6 mm) where position has structural implications or affects concrete cover; otherwise, Plus or Minus 1/2 inch (13 mm).

5. Reinforcing Steel Extending out of Member: Plus or Minus 1/2 inch (13 mm) of plan dimensions.

6. Tendons: Plus or Minus 1/4 inch (6 mm), vertical; Plus or Minus 1 inch (25 mm), horizontal.

7. Location of Rustication Joints: Plus or Minus 1/8 inch (3 mm).

## PART 3- EXECUTION

1.1 GENERAL

G. A pre-installation conference shall be held prior to delivery of Precast Concrete Wall Panels. The sub-contractor for work under this section, the general contractor and owner shall be in attendance to review the following items:

1. Schedule indicating panel delivery dates and panel installation.
2. Safety Plan.
3. Staging plan indicating installation equipment locations and material storage areas.

B. Cranes and lifts required for Prefabricated wall panel installation shall only be permitted in the areas indicated on the drawings.

C. Installation of prefabricated panels shall occur weekdays between the hours of 4pm thru 7am.

3.2 PREPARATION

A. Deliver anchorage devices that are embedded in or attached to the building structural frame or foundation before start of such work. Provide locations, setting diagrams, and templates for the proper installation of each anchorage device.

3.3 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Do not install precast concrete units until supporting cast-in place concrete building structural framing has attained minimum allowable design compressive strength or supporting steel or other structure is structurally ready to receive the loads required from the Prefabricated Wall Panel system.

3.4 ERECTION

A. Install loose clips, hangers, bearing pads and other accessories required for connecting Prefabricated Wall Panel system to supporting members and backup materials.

B. Erect Panels level, plumb and square within the specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

C. Connect Panels in position by bolting, welding, grouting, or as otherwise indicated on approved Erection Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting are completed.

D. Welding: Comply with applicable AWS D1.1 and AWS D1.4 requirements for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect Panels and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
2. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS.
3. Clean weld affected metal surfaces with chipping hammer followed by brushing then apply a minimum 0.004 inch (100 µm) thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A780 or re-prime damaged area as dictated by erection drawings.
4. Visually inspect all welds critical to precast connections. Visually check all welds for completion and remove, reweld or repair all defective welds, if services of AWS-certified welding inspector are not furnished by Owner.

E. At bolted connections, use lock washers, tack welding, or other acceptable means to prevent loosening of nuts after final adjustment.

3.5 ERECTION TOLERANCES

A. Erect units level, plumb, square, true, and in alignment without exceeding the non-cumulative erection tolerances of PCI MNL 117, Appendix I.

B. Erect units level, plumb, square, and true, without exceeding the following non-cumulative erection tolerances.

1. Plan Location from Building Grid Datum: Plus or Minus 1/2 inch (13 mm).
2. Plan Location from Centerline of Steel: Plus or Minus 1/2 inch (13 mm).
3. Top Elevation from Nominal Top Elevation: As follows:
   a. Exposed Individual Panel: Plus or Minus 1/4 inch (6 mm).
   b. Non-exposed Individual Panel: Plus or Minus 1/2 inch (13 mm).
   c. Exposed Panel Relative to Adjacent Panel: 1/4 inch (6 mm).
   d. Non-exposed Panel Relative to Adjacent Panel: 1/2 inch (13 mm).
4. Support Elevation from Nominal Support Elevation: As follows:
   a. Maximum Low: 1/2 inch (13 mm).
   b. Maximum High: 1/4 inch (6 mm).

5. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet (30 m): 1 inch (25 mm).
6. Plumb in Any 10 Feet (3 m) of Element Height: 1/4 inch (6 mm).
7. Maximum Jog in Alignment of Matching Edges: 1/4 inch (6 mm).
8. Joint width (Governs over Joint Taper): Plus or Minus 1/4 inch (6mm).
9. Maximum Joint Taper: 3/8 inch (10 mm).
10. Joint Taper in 10 Feet (3 m): 1/4 inch (6 mm).
11. Maximum Jog in Alignment of Matching Faces: 1/4 inch (6 mm).
12. Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 1/4 inch (6 mm).
13. Opening Height between Spandrels: Plus or Minus 1/4 inch (± 6 mm).

3.6 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections.
B. Field welds will be subject to visual inspections and non-destructive testing in accordance with ASTM E165 or ASTM E709.
C. Testing agency will report test results promptly and in writing to Contractor and Architect.
D. Repair or remove and replace work that does not comply with specified requirements.
E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.7 REPAIRS

A. Repairs will be permitted provided structural adequacy of units and appearance are not impaired.
B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780.
D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
E. Remove and replace damaged units when repairs do not meet requirements.

3.8 CLEANING

A. Clean all surfaces of precast concrete to be exposed to view, as necessary, prior to shipping. All units are delivered to the project site ready for installation clean and free of surface defects.
B. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.
C. Clean exposed surfaces of units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

END OF SECTION

**SECTION 034910 – GLASS FIBER REINFORCED CONCRETE (GFRC)**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following: Glass fiber reinforced concrete (GFRC) panels, consisting of GFRC, cold formed metal framing, anchors, and connection hardware. Work under this section shall include installation of GFRC panels including all panel to panel connections, all connections to the superstructure and installation of elastomeric sealants at all perimeter panel joints.

1.3 DEFINITIONS

A. Design Reference Sample: Sample of approved GFRC color, finish and texture, preapproved by Architect.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide GFRC panels, including panel frames, anchors, and connections, capable of withstanding the following design loads, as well as the effects of thermal- and moisture-induced volume changes, according to load factors and combinations established in PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panel."
   1. Design Loads: in accordance with the requirement of the “Design Table” on drawing S100..
   2. Deflection: Design panel frames to withstand design loads without lateral deflections greater than 1/240 of wall span.
   3. Thermal Movements: Provide for thermal movements resulting from annual ambient temperature changes of 100 degF (56 degC).
   4. Design panel frames and connections to accommodate deflections and other building movements.
   5. Design panel frames to withstand dead loads of adjacent panels where indicated on drawings
   6. Design panel frames to support dead load of building signage where indicated on drawings

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include GFRC design mixes.

B. Samples:

   1 Submit initial samples for verification, approximately 12” x 12”:, representative of finished exposed face.

   2 Submit final samples for approval approximately 12” x 12”, representative of finished exposed face.

C. Shop Drawings: Show fabrication and installation details for GFRC panels, including the following:

1. Structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Panel elevations, sections, and dimensions.
3. Thickness of facing mix, GFRC backing, and bonding pads for typical panels.
4. Finishes.
5. Joint and connection details.
6. Erection details.
7. Panel frame details for typical panels, including sizes, spacings, thicknesses, and yield strengths of various members.
8. Locations and details of connection hardware attached to structure.
9. Size, location, and details of flex, gravity, and seismic anchors for typical panels.
10. Other items sprayed into panels.
11. Erection sequence for special conditions.
12. Relationship to adjacent materials.
13. Descriptions of loose, cast-in, and field hardware

.

D. Comprehensive engineering analysis and calculations singed and sealed by the qualified professional engineer, licensed in the State of Wisconsin, responsible for its preparation.

E. Steel Sheet Certification. For steel sheet used in cold-formed steel panel framing

F. Qualification Data: For GFRC manufacturer, including proof of current PCI Plant Certification.

G. Source Quality-Control Program: For GFRC manufacturer.

H. Source Quality-Control Test Reports: For GFRC, inserts, and anchors.

I. Research/Evaluation Reports: For GFRC.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified manufacturer who participates in PCI's Plant Certification Program and is designated a PCI-Certified Plant for Group G, Glass Fiber Reinforced Concrete.
   1. Manufacturer's responsibility includes fabricating and installing GFRC panels and providing professional engineering services needed to assume engineering responsibility for GFRC panels.
   2. Regularly engaged for at least five (5) years in fabrication of precast concrete wall panels similar to those required on this project.

B. Installer Qualifications: Regularly engaged for at least five (5) years in installation of precast concrete wall panels similar to those required on this project.

C. Steel Sheet Certifications: Obtain mill certificates, signed by manufacturers of steel sheet or test reports from a qualified testing agency indicating steel sheet used in cold-formed metal panel framing complies with requirements, including uncoated steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and galvanized-coating thickness.

D. Source Limitations: Obtain GFRC panels through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

F. PCI Manuals: Comply with requirements and recommendations in the following PCI manuals, unless more stringent requirements are indicated:
   1. PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panels."
   2. PCI MNL 130, "Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products."

G. AISI Specifications: Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members."

H. Mockup Panel: .
   1. After standard samples are accepted for color and texture, produce one full-scale panel a minimum of 4 feet x 8-feet, meeting design requirements. This panel shall be viewed and approved by the owner and architect at the project location prior to production of panels.
   2. The approved mock-up panel shall be representative of standard quality for the GFRC panels for this project..

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and transport GFRC panels to avoid damage.
   1. Place nonstaining resilient spacers between panels.
   2. Support panels during shipment on nonstaining material.
   3. Protect panels from dirt and damage during handling and transport.

B. Store GFRC panels to protect from contact with soil, staining, and physical damage.
   1. Store panels with nonstaining resilient supports in same positions as when transported.
   2. Store panels on firm, level, and smooth surfaces.
   3. Place stored panels so identification marks are clearly visible.

**PART 2 - PRODUCTS**

2.1 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 following:
   1. GFRC LLC
   2. Approved Equal.

2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide continuous and true GFRC surfaces; nonreactive with GFRC and capable of producing required finish surfaces.
   1. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.

## 2.3 GFRC MATERIALS

A. Portland Cement: ASTM C150, Type I, II, or III.
   1. For surfaces exposed to view in finished structure, use white of same type, brand, and source throughout GFRC production

B. Glass Fibers: Alkali resistant, with a minimum zirconia content of 16 percent, 1 to 2 inches (25 to 50 mm) long, specifically produced for use in GFRC, and complying with PCI MNL 130.

C. Sand: Washed and dried silica, complying with composition requirements of ASTM C144; passing No. 20 (0.85-mm) sieve with a maximum of 2 percent passing No. 100 (0.15-mm) sieve.

D. Facing Aggregate: ASTM C33, except for gradation, and PCI MNL 130, 1/4-inch (6-mm) maximum size.
   1. Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match sample.

E. Coloring Admixture: ASTM C979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.

F. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of GFRC and complying with chemical limits of PCI MNL 130

G. Air-Entraining Admixture: ASTM C260, containing not more than 0.1 percent chloride ions.

H. Chemical Admixtures: ASTM C494/C494M, containing not more than 0.1 percent chloride ions.

## 2.4 ANCHORS, CONNECTORS, AND MISCELLANEOUS MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A36/A36M. Finish steel shapes and plates less than 3/16 inch (4.76 mm) thick as follows:
   1. Finish: Zinc coated by hot-dip process according to ASTM A123/A123M, after fabrication, or ASTM A153/A153M, as applicable.

B. Carbon-Steel Bars: ASTM A108, AISI Grade 1018. Finish steel bars less than 3/16 inch (4.76 mm) thick as follows:
   1. Finish: Zinc coated by hot-dip process according to ASTM A123/A123M, after fabrication, or ASTM A153/A153M, as applicable

C. Malleable-Iron Castings: ASTM A47/A47M, Grade 32510 (Grade 22010).

D. Carbon-Steel Castings: ASTM A27/A27M, Grade 60-30 (Grade 415-205).

E. Bolts: ASTM A307 or ASTM A325 (ASTM F568M or ASTMA325M).

## 2.5 PANEL FRAME MATERIALS

A. Cold-Formed Steel Framing: Manufacturer's standard C-shaped steel studs, complying with AISI's "Specification for the Design of Cold-Formed Steel Structural Members," minimum uncoated steel thickness of 0.0538 inch (1.37 mm), with stiffened flanges, U-shaped steel track, and of the following steel sheet:
   1. Metallic-Coated Steel Sheet: ASTM A 653/A653M, structural-steel sheet, G90 (Z275) zinc coating, of grade required by structural performance of framing.

B. Steel Channels and Angles: ASTM A36/A36M, finished as follows:
   1. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP6/NACE No. 3, "Commercial Blast Cleaning."

## 2.6 GFRC MIXES

A. Backing Mix: Proportion backing mix of portland cement, glass fibers, sand, and admixtures to comply with design requirements. Provide nominal glass-fiber content of not less than 5 percent by weight of total mix.

B. Face Mix: Proportion face mix of portland cement, fine and coarse aggregates, and admixtures to comply with design requirements.

C. Air Content: 8 to 10 percent; ASTM C185.

D. Coloring Admixture: Not to exceed 10 percent of cement weight.

## 2.7 PANEL FRAME FABRICATION

A. Fabricate panel frames and accessories plumb, square, true to line, and with components securely fastened, according to Shop Drawings and requirements in this Section.
   1. Fabricate panel frames using jigs or templates.
   2. Cut cold-formed metal framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed metal framing members by welding. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   4. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS D1.1 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   5. Weld flex, gravity, and seismic anchors to panel frames.

B. Reinforce, stiffen, and brace framing assemblies, if necessary, to withstand handling, delivery, and erection stresses. Lift fabricated assemblies in a manner that prevents damage or significant distortion.

C. Galvanizing Repair: Touch up accessible damaged galvanized surfaces according to ASTM A780.

## 2.8 MOLD FABRICATION

A. Construct molds that will result in finished GFRC complying with profiles, dimensions, and tolerances indicated, without damaging GFRC during stripping. Construct molds to prevent water leakage and loss of cement paste.
   1. Coat contact surfaces of molds with form-release agent.

## 2.9 GFRC FABRICATION

A. Proportioning and Mixing: For backing mix, meter sand/cement slurry and glass fibers to spray head at rates to achieve design mix proportions and glass-fiber content according to PCI MNL 130 procedures.

B. Spray Application: Comply with general procedures as follows:

1. Spray or place face mix in thickness indicated on Shop Drawings.
2. Proceed with spraying backing mix before face mix has set, using procedures that produce a uniform thickness and even distribution of glass fibers and matrix.
3. Consolidate backing mix by rolling or other technique to achieve complete encapsulation of glass fibers and compaction.
4. Measure thickness with a pin gage or other acceptable method at least once for each 5 sq. ft. (0.5 sq. m) of panel surface. Take not less than six measurements per panel.

C. Hand form and consolidate intricate details, incorporate formers or infill materials, and over spray before material reaches initial set to ensure complete bonding.

D. Attach panel frame to GFRC before initial set of GFRC backing, maintaining a minimum clearance of 1/2 inch (13 mm) from GFRC backing, and without anchors protruding into GFRC backing.

E. Build up homogeneous GFRC bonding pads over anchor feet, maintaining a minimum thickness of 1/2 inch (13 mm) over top of anchor foot, before initial set of GFRC backing.

F. Inserts and Embedments: Build up homogeneous GFRC bosses or bonding pads over inserts and embedments to provide sufficient anchorage and embedment to comply with design requirements.

G. Curing: Employ initial curing method that will ensure sufficient strength for removing units from mold.
1. After initial curing, remove panel from mold and place in a controlled curing environment.
2. Keep GFRC panels continuously moist for a minimum of seven days, unless polymer curing admixture was used. Maintain temperature between 60 and 120 degF (16 and 49 degC) during this period.

H. Panel Identification: Mark each GFRC panel to correspond with identification mark on Shop Drawings. Mark each panel with its casting date.

## 2.10 FABRICATION TOLERANCES

A. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with the following dimensional tolerances. For dimensional tolerances not listed below, comply with PCI MNL 130.
1. Overall Height and Width of Units, Measured at the Face Adjacent to Mold: As follows:
    a. 10 feet (3 m) or under, plus or minus 1/8 inch (3 mm).
    b. More than 10 feet (3 m), plus or minus 1/8 inch per 10 feet (3 mm per 3 m); 1/4 inch (6 mm) maximum.
2. Edge Return Thickness: Plus 1/2 inch (13 mm), minus 0 inch (0 mm).
3. Architectural Facing Thickness: Plus 1/8 inch (3 mm), minus 0 inch (0 mm).
4. Backing Thickness: Plus 1/4 inch (6 mm), minus 0 inch (0 mm).
5. Angular Variation of Plane of Side Mold: Plus or minus 1/32 inch per 3 inches (0.8 mm per 75 mm) of depth or plus or minus 1/16 inch (1.5 mm) total, whichever is greater.
6. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1800 mm) or plus or minus 1/4 inch (6 mm) total, whichever is greater.
7. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
8. Bowing: Not to exceed L/240 unless unit meets erection tolerances using connection adjustments.
9. Maximum Permissible Warpage of One Corner out of the Plane of the Other Three: 1/16 inch per 12 inches (1.5 mm per 300 mm) of distance from nearest adjacent corner.

B. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.
   1. Panel Frame and Track: Plus or minus 1/4 inch (6 mm).
   2. Flashing Reglets at Edge of Panel: Plus or minus 1/4 inch (6 mm).
   3. Inserts: Plus or minus 1/2 inch (13 mm).
   4. Special Handling Devices: Plus or minus 3 inches (75 mm).
   5. Location of Bearing Devices: Plus or minus 1/4 inch (6 mm).
   6. Blockouts: Plus or minus 3/8 inch (10 mm).

C. Panel Frame Tolerances: As follows:
   1. Vertical and Horizontal Alignment: 1/4 inch per 10 feet (6 mm per 3 m).
   2. Spacing of Framing Member: Plus or minus 3/8 inch (10 mm).
   3. Squareness of Frame: Difference in length of diagonals of 3/8 inch (10 mm).
   4. Overall Size of Frame: Plus or minus 3/8 inch (10 mm).

2.11 FINISHES

A. Finish exposed-face surfaces of GFRC as follows to match existing marble clad column enclosures.
   1. Acid-Etched Finish: Use acid and hot-water solution equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.

2.12 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Establish and maintain a quality-control program for manufacturing GFRC panels according to PCI MNL 130.
   1. Test materials and inspect production techniques.
   2. Quality-control program shall monitor glass fiber content, spray rate, unit weight, product physical properties, anchor pull-off and shear strength, and curing period and conditions.
   3. Prepare test specimens and test according to ASTM C1228, PCI MNL 128, and PCI MNL 130 procedures.
   4. Test GFRC inserts and anchors according to ASTM C1230 to validate design values.
   5. Produce test boards at a rate not less than one per work shift per operator for each spray machine and for each mix design.
      a. For each test board, determine glass fiber content according to ASTM C1229, and flexural yield and ultimate strength according to ASTM C947.

**PART 3 - EXECUTION**

3.1 GENERAL

A. A pre-installation conference shall be held prior to delivery of Prefabricated Wall Panels. The sub-contractor for work under this section, the general contractor and owner shall be in attendance to review the following items:

   1. Schedule indicating panel delivery dates and panel installation.

   2. Safety Plan.

   3. Staging plan indicating installation equipment locations and material storage areas.

B. Cranes and lifts required for Prefabricated wall panel installation shall only be permitted in the areas indicated on the drawings.

C. Installation of prefabricated panels shall occur weekdays between the hours of 4pm thru 7am.

## 3.2 EXAMINATION

A. Examine structure and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.3 ERECTION

A. Install clips, hangers, and other accessories required for connecting GFRC panels to supporting members and backup materials.

B. Lift GFRC panels and install without damage.

C. Install GFRC panels level, plumb, square, and in alignment. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.
   1. Maintain horizontal and vertical joint alignment and uniform joint width.
   2. Remove projecting hoisting devices.

D. Connect GFRC panels in position by bolting or welding, or both, as indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as possible after connecting is completed.

E. Welding: Comply with applicable AWS D1.1 and AWS D1.3 requirements for welding, appearance, quality of welds, and methods used in correcting welding work.
   1. Protect GFRC panels from damage by field welding or cutting operations, and provide noncombustible shields as required.

F. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.

G. Install elastomeric sealant at all perimeter panel joints in accordance with Section 7 “Joint Sealants”

## 3.4 ERECTION TOLERANCES

A. Erect GFRC panels to comply with the following noncumulative tolerances:
   1. Plan Location from Building Grid Datum: Plus or minus 1/2 inch (13 mm).
   2. Top Elevation from Nominal Top Elevation: As follows:
      a. Exposed Individual Panel: Plus or minus 1/4 inch (6 mm).
      b. Nonexposed Individual Panel: Plus or minus 1/2 inch (13 mm).
      c. Exposed Panel relative to Adjacent Panel: 1/4 inch (6 mm).
      d. Nonexposed Panel relative to Adjacent Panel: 1/2 inch (13 mm).
   3. Support Elevation from Nominal Elevation: As follows:
      a. Maximum Low: 1/2 inch (13 mm).
      b. Maximum High: 1/4 inch (6 mm).
   4. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet (30 m): 1 inch (25 mm).
   5. Plumb in Any 10 Feet (3 m) of Element Height: 1/4 inch (6 mm).
   6. Maximum Jog in Alignment of Matching Edges: 1/4 inch (6 mm).
   7. Maximum Jog in Alignment of Matching Faces: 1/4 inch (6 mm).
   8. Face Width of Joint: As follows (governs over joint taper):
      a. Panel Dimension 20 Feet (6 m) or Less: Plus or minus 1/4 inch (6 mm).
      b. Panel Dimension More Than 20 Feet (6 m): Plus or minus 5/16 inch (8 mm).

9. Maximum Joint Taper: 3/8 inch (10 mm).
10. Joint Taper in 10 Feet (3 m): 1/4 inch (6 mm).
11. Differential Bowing, as Erected, between Adjacent Members of Same Design: 1/4 inch (6 mm).

## 3.5 REPAIRS

A. Repairs will be permitted provided structural adequacy of GFRC panel and appearance are not impaired, as approved by Architect.

B. Mix patching materials and repair GFRC so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces.

C. Prepare and repair accessible damaged galvanized coatings with galvanizing repair paint according to ASTM A780.

D. Remove and replace damaged GFRC panels when repairs do not comply with requirements.

## 3.6 CLEANING AND PROTECTION

A. Perform cleaning procedures, if necessary, according to GFRC manufacturer's written instructions. Clean soiled GFRC surfaces with detergent and water, using soft fiber brushes and sponges, and rinse with clean water. Prevent damage to GFRC surfaces and staining of adjacent materials.

END OF SECTION

**SECTION 042000 - UNIT MASONRY**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:

1. Concrete masonry units.

2. Mortar and grout.

3. Reinforcing steel.

4. Masonry joint reinforcement.

5. Miscellaneous masonry accessories.

B. Products installed, but not furnished, under this Section include the following:

1. Hollow-metal frames in unit masonry openings, furnished under Division 8 Section "Steel Doors and Frames."

1.3 DEFINITIONS

A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops the following net-area compressive strengths (f'm) at 28 days. Determine compressive strength of masonry units and mortar types (unit-strength method) according to tables 1 and 2 in ACI 530.1/ASCE6/TMS602..

1. For Concrete Unit Masonry: f'm = 2500 psi.

1.5 SUBMITTALS

A. Product Data: For each different masonry unit, accessory, and other manufactured product specified.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:

1. Each type of masonry unit required.

a. Include test results, measurements, and calculations establishing net-area compressive strength of masonry units.

2. Mortar complying with property requirements of ASTM C 270.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1093 to conduct the testing indicated, as documented according to ASTM E 548.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

1. Protect Type I concrete masonry units from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

A. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface.

2. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

C. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.

1. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

## PART 2 - PRODUCTS

### 2.1 CONCRETE MASONRY UNITS

A. General: Provide shapes indicated and as follows:

1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.

B. Concrete Masonry Units: ASTM C 90 and as follows:

1. Weight Classification: Normal weight, unless otherwise indicated.

2. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

a. Where units are to be left exposed, provide color and texture matching the range represented by Architect's sample.

### 2.2 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type II except type III may be used for cold weather construction. Provide natural color cement.

B. Hydrated Lime: ASTM C 207, Type S.

C. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

D. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.

E. Water: Potable.

F. Products: Subject to compliance with requirements, provide one of the following:

a. Accelguard 80; Euclid Chemical Co.

b. Morseled; W. R. Grace & Co., Construction Products Division.

c. Trimix-NCA; Sonneborn, Div. of ChemRex, Inc.

2.3 MASONRY JOINT REINFORCEMENT

A. Uncoated steel reinforcement bars ASTM A615/A615M or ASTM A96/A 996/M, Grade 60.

B. General: ASTM A 951 and as follows:

1. Mill galvanized, carbon-steel wire for interior walls.

2. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units where indicated.

C. For single-wythe masonry, provide either ladder or truss type with single pair of side rods and cross rods spaced not more than 16 inches o.c.

2.4 MISCELLANEOUS MASONRY ACCESSORIES

A. Preformed Control-Joint Gaskets: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

1. Styrene-Butadiene-Rubber Compound: ASTM D 2000, Designation M2AA-805.

B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.5 MASONRY CLEANERS

A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.

2.6 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Add cold-weather admixture (if used) at the same rate for all mortar, regardless of weather conditions, to ensure that mortar color is consistent.

3. Limit cemetitious materials in mortar to Portland cement and lime.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification.

1. Type S.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.

2. Verify that foundations are within tolerances specified.

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

B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.2 INSTALLATION, GENERAL

A. Thickness: Build single-wythe walls to the actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specifications.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.

D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 CONSTRUCTION TOLERANCES

A. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:

B. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.

C. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, nor 1/2 inch maximum.

D. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.

E. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

F. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

1. One-half running bond with vertical joint in each course centered on units in courses above and below.

C. Stopping and Resuming Work: In each course, rack back one-half-unit length for one-half running bond do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.

E. Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

G. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow masonry units as follows:

1. With full mortar coverage on horizontal and vertical face shells.

2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.

3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than the joint thickness, unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Provide continuous masonry joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joints in unit masonry at a maximum spacing of 20-feet on center. Locations require approval of architect prior to installation. Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake joints in exposed faces.

3.8 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

1. Provide or built-in-place masonry lintels. Use specially formed bond beam units with reinforcing bars placed as indicated and filled with coarse grout. Temporarily support built-in-place lintels until cured.

C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.9 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing the surfaces thoroughly with clear water.

3.10 MASONRY WASTE DISPOSAL

A. Recycling: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

**END OF SECTION**

## SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

## PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes structural steel and grout.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator with a minimum of five years experience on projects of similar magnitude.

B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

C. Comply with applicable provisions of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

## PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992.

B. Channels, Angles, M, S-Shapes: ASTM A 36.

C. Plate and Bar: ASTM A 36 Grade unless specifically noted on drawings.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B**,** structural tubing.

E. Steel Pipe: ASTM A 53, Type E or S, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

## 2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Plain.

B. Threaded Rods: ASTM A 36.

1. Finish: Plain.

## 2.3 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

## 2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges".

## 2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

## 2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

## PART 3 - EXECUTION

### 3.1 ERECTION

A. Examination: Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

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

B. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges".

C. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of base plate.
3. Snug-tighten (except where specifically noted to the contrary) anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions.

D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

### 3.2 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds.

B. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

C. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

**END OF SECTION 05 12 00**

## SECTION 054000 COLD FORMED METAL FRAMING

## PART 1 – GENERAL

1.1 SCOPE

A. Perform all Work required to complete the Exterior Cold-Formed Metal Framing as indicated by the Contract Documents, and furnish all items necessary for its proper installation.

B. Include all "C" shaped steel studs and "C" shaped steel joists 18 gauge and heavier indicated on the contract documents. Include all bridging, bracing and connections required.

1.2 REFERENCES

A. American Institute of Steel Construction (AISC).

1. Manual of Steel Construction.

B. American Iron and Steel Institute (AISI).

1. Design of Cold-Framed Steel Structural Members.

C. American Society for Testing and Materials (ASTM).

1. ASTM A446, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.

D. American Welding Society (AWS).

1. D1.1 – Structural Welding Code.
2. D1.3 – Light Steel Welding Code.

1.3 QUALIFICATIONS

A. Quality welding processes and welding operators in accord with AWS D1.3.

1.4 SUBMITTALS

A. Submit manufacturer's product information for each item of cold-framed metal framing and accessories.

B. Submit shop drawings and calculations for special components and installations not fully dimensioned or detailed in manufacturer's product data.

C. Submit placing drawings prepared and stamped by licensed professional engineers in the State of Wisconsin for framing members showing size and gauge designations, number, type, location and spacing. Indicate supplemental strapping, bracing, splices, bridging, accessories and details required for proper installation.

D. Limit lateral deflection of studs under wind load to L/360.

E. Welder certification shall be submitted upon request, from the Architect/Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site dry and store above ground on wood blocking. Do not bend studs or tracks during handling. Any studs or tracks which are bent during handling shall be replaced with new materials.

**PART 2 – PRODUCTS**

2.1 MANUFACTURERS

A. Cold-formed metal framing shall be of products as manufactured by Dietrich Industries, Inc., Clark Steel Framing Systems, or approved equal.

2.2 MATERIALS

A. Cold-Formed Metal Framing:

1. Cold-formed metal framing shall use manufacturer's standard steel members of type, size, shape, and gage as indicated on the Drawings. With each type of metal framing required, provide manufacturer's standard steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners and accessories for applications indicated, as required to provide a complete cold-formed metal framing system.

a) For units of 18 gauge and heavier, fabricate components of structural quality sheet steel with a minimum yield point of 50,000 psi conforming with ASTM A446.
b) For units of 18 gauge and lighter, fabricate components of commercial quality steel sheet with a minimum yield of 33,000 psi conforming with ASTM A446.
c) Provide galvanized finish to panel components complying with ASTM A653 for a minimum G60 coating. Finish of installation accessories shall match that of main framing components, unless otherwise indicated.
d) All materials shall be 18 gauge or heavier.
e) "C" shape studs shall be manufacturer's standard load bearing or curtainwall studs of size, shape and gauge indicated with minimum 1-5/8 inch flange and flange return lip.
f) Joists and rafters shall be manufacturer's standard "C" shape sections of size, shape and gauge indicated.

B. Framing Accessories:

1. Bracing and bridging shall be formed from sheet steel, minimum 20 gauge, manufacturer's standard shapes. Finish shall be the same as framing members.

2. Plates, gussets, clips shall be formed from sheet steel, thickness determined for conditions encountered, manufacturer's standard shapes. Finish shall be the same as framing members.

C. Electrodes for Welding:

1. Electrodes for SMAW shall conform with AWS, A5.1 or AWS, A5.5.

D. Galvanizing Repair Paint:

1. Repair paint shall have a high zinc dust content for use on galvanized surfaces damaged by welding.

**PART 3 – EXECUTION**

3.1 ERECTION OF MISCELLANEOUS FRAMING

A. Fabricate framing for maximum coverage between column to column, floor to floo, and foundation to parapet.

B. Uniform and level frame bearing shall be provided at concrete and masonry walls by means of shims and non-settling grout.

C. Attach components by welding. Minimum weld requirement of framing member to track shall be an 1/8 inch fillet by 1 ½ inches long on each framing leg. Wire tying of framing components shall not be permitted.

D. Install continuous track sized to match studs. Align track accurately to layout at base and tops of studs. Abutting lengths of track shall be securely anchored to a common structural element, or they shall be butt-welded or spliced together.

E. Stud spacing shall maintain a 16 inch on center spacing throughout framing. Location of stud back up at veneer expansions joints shall not cause interruption of the 16 inch on center stud spacing.

F. Axially located studs shall be installed in a manner which shall assure that ends of the studs are positioned against the inside runner (track) web, prior to stud and runner attachment.

G. Jack studs or cripples shall be installed below window sills, above window or door heads, at freestanding stair rails, and elsewhere to furnish support, and shall be securely attached to supporting members.

H. Framed wall openings shall include headers and supporting studs as shown on Drawings. Unless noted on the Drawings, provide headers above all openings consisting of minimum two studs on edge (matching size and gauge of wall studs) with track top and bottom of header.

I. No splicing of studs shall be permitted.

J. No gas cutting of studs shall be permitted.

K. Wall studs shall be properly braced to prevent stud rotation and bending. Install wall stud bridging rows spaced according to the manufacturer's recommendations. Without supportive data, the minimum bridging shall be 5 feet on center for wind loaded walls and 3 feet to 4 feet on center for load bearing walls. Note, lateral bracing may be provided by gypsum board or gypsum sheathing and bridging may be omitted. Contact Architect/Engineer for evaluation.

L. Temporary bracing, where required, shall be provided until erection is completed.

3.2 WELDING

A. Welding of panels to supports and of panel bridging shall be performed by certified welders in accordance with AWS D1.3.

B. All connections shall be welded, including kickers and bracing. No mechanical fasteners shall be allowed.

3.3 FIELD PAINTING

A. Touch-up shop applied protective coatings damaged during handling and installation. Use a galvanizing repair paint for galvanized surfaces.

B. Touch-up field welded areas with galvanizing repair paint.

END OF SECTION 054000

**SECTION 061000- ROUGH CARPENTRY**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Wood blocking and nailers.

2. Plywood backing panels.

1.3 DEFINITIONS

A. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NELMA - Northeastern Lumber Manufacturers Association.

2. NLGA - National Lumber Grades Authority.

3. SPIB - Southern Pine Inspection Bureau.

4. WCLIB - West Coast Lumber Inspection Bureau.

5. WWPA - Western Wood Products Association.

1.4 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.

B. Include copies of warranties from chemical treatment manufacturers for each type of LEED Submittals:

1. Certificates for Credit MR 6, Credit MR 7: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.

2. Product Data for Credit EQ 4.1: For adhesives, documentation including printed statement of VOC content.
3. Product Data for Credit EQ 4.4: For composite wood products, documentation indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports for Credit EQ 4: For adhesives and composite-wood products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels; place spacers between each bundle to provide air circulation. 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 lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. Provide dressed lumber, S4S, unless otherwise indicated.

3. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.2 MISCELLANEOUS LUMBER

A. General: Provide lumber for support or attachment of other construction, including the following:

1. Blocking.

2. Nailers.

B. For items of dimension lumber size, provide Construction, Stud, or No. 2, 19 percent maximum moisture content and any of the following species:

1. Mixed southern pine; SPIB.

2. Hem-fir or Hem-fir (north); NLGA, WCLIB, or WWPA.

3. Spruce-pine-fir (south) or Spruce-pine-fir; NELMA, NLGA, WCLIB, or WWPA.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.

2. Hem-fir or Hem-fir (north), Construction or 2 Common grade; NLGA, WCLIB, or WWPA.

3. Spruce-pine-fir (south) or Spruce-pine-fir, Construction or 2 Common grade; NELMA, NLGA, WCLIB, or WWPA.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Power-Driven Fasteners: CABO NER-272.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M).

G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 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.

2.4 METAL FRAMING ANCHORS

A. General: Provide galvanized steel framing anchors of structural capacity, type, and size indicated and acceptable to authorities having jurisdiction.

B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.

D. Countersink fastener heads on exposed carpentry work and fill holes with wood filler.

E. Use fasteners of appropriate type and length. Predrill members when necessary to avoid splitting wood.

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.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

END OF SECTION

**SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK**

PART 1 - GENERAL

1.1 SUMMARY

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 specification sections apply to work of this section.

B. This Section includes the following:

1. Interior standing and running trim.
2. Interior wood door frames
3. Tongue and Groove wall paneling.
4. Plastic-laminate cabinets.
5. Plastic-laminate countertops.
6. Shop finishing of woodwork.

C. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips unless concealed within other construction before woodwork installation.

1.2 SUBMITTALS

A. Product Data: For solid-surfacing material cabinet hardware and accessories and finishing materials and processes.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

C. Samples:

1. Lumber and panel products for transparent finish, for each species and cut, finished on one side and one edge.
2. Plastic-laminates, for each type, color, pattern, and surface finish.
3. Thermoset decorative panels, for each type, color, pattern, and surface finish.
4. Solid-surfacing materials.

D. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of woodwork.

B. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

C. Provide AWI Quality Certification Program certificates indicating that woodwork complies with requirements of grades specified.

D. Forest Certification: Provide interior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.4 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.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

A. Solid Lumber:
   1. Wood Species and Cut for Transparent Finish: Plain Sliced Maple as indicated on drawings.
   2. Forest Certification: Provide solid wood produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Medium-Density Fiberboard:
   1. ANSI A208.2, Grade MD, made with binder containing no added urea formaldehyde. Provide products with the highest recycled content possible.

C. Particleboard:
   1. ANSI A208.1, Grade M-2, made with binder containing no added urea formaldehyde. Provide products with the highest recycled content possible.

D. Softwood Plywood: DOC PS 1.
   1. Forest Certification: plywood produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

E. Veneer-Faced Panel Products (Hardwood Plywood):
   1. HPVA HP-1, made with adhesive containing no added urea formaldehyde.

2. Wood Species and Cut for Transparent Finish: As indicated on drawings.
3. Forest Certification: Provide plywood produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

F. Thermoset Decorative Panels:
1. Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1 made with binder containing no added urea formaldehyde.
2. Available Manufacturers: Refer to drawings for specific patterns and colors. Subject to compliance with these requirements, manufacturers offering thermoset decorative panels that may be incorporated into the Work include, but are not limited to, the following:
   a. Skyblend by Roseburg Forest Products

G. High-Pressure Decorative Laminate:
1. NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
2. Available Manufacturers: Refer to drawings for specific patterns and colors. Subject to compliance with these requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
   a. Formica Corporation.
   b. Pionite, Nevamar Company, LLC; Decorative Products Div.
   c. Wilsonart International; Div. of Premark International, Inc.
   d. Laminart, Inc.

## 2.2 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural woodwork, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening, self-closing.

C. Back-Mounted Pulls: BHMA A156.9, B02011.
1. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.

D. Drawer Slides: BHMA A156.9, B05091.
1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
2. Grades in three subparagraphs below correspond to the following initial load test requirements: Grade 2: 30 lbf; Grade 1: 50 lbf ; Grade 1HD-100: 100 lbf ; Grade 1HD-200: 200 lbf .
   a. Box Drawer Slides: Grade 1HD-100; for drawers not more than 6 inches high and 24 inches wide.
   b. File Drawer Slides: Grade 1HD-100; for drawers more than 6 inches high or 24 inches wide.
   c. Pencil Drawer Slides: Grade 1; for drawers not more than 3 inches high and 24 inches wide.

E. Door Locks: BHMA A156.11, E07121.

F. Drawer Locks: BHMA A156.11, E07041.

G. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18: Satin Stainless Steel: BHMA 630.

## 2.3 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

B. Adhesives, General: Do not use adhesives that contain added urea formaldehyde.

## 2.4 FABRICATION, GENERAL

A. General: Complete fabrication to maximum extent possible before shipment to Project site. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
   1. Adhesives used must not exceed the allowable VOC limit from the referenced standard, South Coast Air Quality Management District (SCAQMD) Rule #1168, which can be referenced online at http://www.aqmd.gov/rules/reg/reg11/r1168.pdf. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D.
   2. Product data for aerosol adhesives used. Include the manufacturer's name, product name, specific VOC data for each product, and the corresponding allowable VOC from the referenced standard, Green Seal Standard GS-36, which can be referenced online at http://www.greenseal.org/certification/standards/cammercial adhesives GS 36.cfm. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D.

B. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.

C. 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.

D. Fabricate woodwork to dimensions, profiles, and details indicated.

E. 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.

F. 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.

1. Seal edges of openings in countertops with a coat of varnish.

2.5 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Grade: Custom

B. Wood Species and Cut: as indicated

C. For trim items wider than available lumber, use veneered construction. Do not glue for width.

D. For rails wider or thicker than available lumber, use veneered construction. Do not glue for width or thickness.

E. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

F. Assemble casings in plant except where limitations of access to place of installation require field assembly.

G. Assemble moldings in plant to maximum extent possible. Miter corners in plant and prepare for field assembly with bolted fittings designed to pull connections together.

2.6 INTERIOR DOOR FRAMES AND JAMBS FOR TRANSPARENT FINISH

A. Grade: Custom

B. Wood Species and Cut: as indicated.

C. For frames or jambs wider than available lumber, use veneered construction. Do not glue for width.

2.7 TONGUE AND GROOVE WOOD BOARDS FOR A TRANSPARENT FINISH

A. The wood tongue and groove boards in this subparagraph applies to the following:

1. 7th floor east conference room

B. Grade: custom

C. Species: as indicated

D. Install boards in sizes and pattern as indicated

E. Boards shall have a smooth face.

F. Wood Boards shall comply with the requirements of a Class C finish. They shall have a flame -spread index of 200 or less and smoke-developed index of 450 or less when tested in accordance with ASTM E 84.

## 2.8 PLASTIC-LAMINATE CABINETS

A. Grade: Custom.

B. AWI Type of Cabinet Construction: Flush overlay.

C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:

1. Horizontal Surfaces Other Than Tops: Grade HGS.
2. Postformed Surfaces: Grade HGP.
3. Vertical Surfaces: Grade HGS.
4. Edges: Grade HGS.

D. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.

   a. Edges of Plastic-Laminate Shelves: PVC tape, 0.018-inch minimum thickness, matching laminate in color, pattern, and finish.
   b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.

2. Drawer Sides and Backs: Thermoset decorative panels.
3. Drawer Bottoms: Thermoset decorative panels.

E. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.

F. 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 selected by Architect from laminate manufacturer's full range

## 2.9 PLASTIC-LAMINATE COUNTERTOPS

A. Grade: Custom.

B. High-Pressure Decorative Laminate Grade: HGP.

C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   a. As selected by Architect from manufacturer's full range

D. Edge Treatment: Same as laminate cladding on horizontal surfaces.

E. Core Material: Particleboard or medium-density fiberboard.

F. Core Material at Sinks: exterior-grade plywood

G. Backer Sheet: Provide plastic-laminate backer sheet, Grade BKL, on underside of countertop substrate.

H. Paper Backing: Provide paper backing on underside of countertop substrate.

## 2.10 SHOP FINISHING SOLID LUMBER AND HARDWOOD PLYWOOD

A. Finish architectural woodwork at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.
   1. Sealants used must not exceed the allowable VOC limit from the referenced standard, South Coast Air Quality Management District (SCAQMD) Rule #1168, which can be referenced online at http://www.aqmd.gov/rules/reg/reg11/r1168.pdf. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D.

B. Provide hardwood edge banding, same species, at all edges exposed to view.

C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: AWI conversion varnish or catalyzed polyurethane system.
   3. Effect: Open-grain finish.
   4. Sheen: Satin.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas. Allow woodwork to acclimate on site for a period of one week prior to installation.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

## 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 or finishing screws 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 96 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 wall railings on indicated metal brackets securely fastened to wall framing.
3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).

G. Tongue and Groove Boards: Anchor boards to supporting substrate with concealed fasteners. Do not use face fastening, unless otherwise indicated.

1. Install boards with no more than 1/16 inch in 96-inch vertical cup or bow and 1/8 inch in 96-inch horizontal variation from a true plane.

H. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Maintain veneer sequence matching of cabinets with transparent finish.
3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c.

I. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Align adjacent solid-surfacing-material 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 [to tops with concealed metal brackets at 16 inches (400 mm) o.c and to walls with adhesive.
4. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

J. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

## 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

## SECTION 07 18 00 - TRAFFIC COATINGS

## 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 traffic coatings for the following applications:
   1. The traffic coating will serve as a temporary waterproof membrane protection of the existing structural slab during the period of time that there is no exterior wall enclosure at the areas where new mechanical shafts are being installed (refer to areas on drawings indicated to receive traffic toppings and/or traffic coatings).

1.3 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.

C. Samples for Verification: For each type of traffic coating required, prepared on rigid backing and of same thickness and material indicated for the Work.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of traffic coatings required for this Project.

B. Source Limitations:

   1. Obtain traffic coatings from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels.

B. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.

B. Do not install traffic coating until items that will penetrate membrane have been installed.

C. Subcontractor responsible for this section of work shall provide adequate ventilation in area that is to receive traffic coatings so that no fumes from the application of the traffic coatings migrate into adjacent work areas occupied by owner.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which traffic coating manufacturer agrees to repair or replace traffic coatings that deteriorate during the specified warranty period.

1. Warranty Period: Duration of construction .

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. Traffic Coatings: Complying with ASTM C 957.

B. Material Compatibility: Provide primers; and traffic coatings ; and miscellaneous materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.2 TRAFFIC COATING

A. Basis of Design Product Subject to compliance with requirements provide Tremco Incorporated, Sealant/Waterproofing Division; Vulkem 351 Elastomeric, Waterproof Traffic Deck Coating System , or an equivalent product by one of the following manufacturers:

1. BASF Construction Chemicals, LLC
2. Carlisle Coatings & Waterproofing, Inc

B. Primer: Manufacturer's standard factory-formulated primer as recommended or required for system, substrate and conditions indicated.

C. Traffic Coating: Two component polyurethane membrane.

1. Coating Thickness: 30-mils minimum wet film
2. Color: As selected by Architect and Engineer from manufacturer's full range.

D. Aggregate: Uniformly graded, washed 20-30 mesh aggregate and minimum hardness recommended in writing by traffic coating manufacturer.
   1. Spreading Rate: As recommended by manufacturer for substrate and service conditions indicated, but not less than the following:
      a. 15 – 20 lbs/100 square feet.

2.3 MISCELLANEOUS MATERIALS

A. Joint Sealants: Tremco Dymeric 240 FC.

**B.** Reinforcing Strip: 12” woven cloth mesh; Tremco Reemay or approved equal.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements and for other conditions affecting performance of traffic coatings.

3.2 PREPARATION

A. Clean and prepare substrates according to ASTM C 1127 and manufacturer's written recommendations to produce clean, dust-free, dry substrate for traffic coating application.

B. Mask adjoining surfaces not receiving traffic coatings, deck drains, and other deck substrate penetrations to prevent spillage, leaking, and migration of coatings.

C. Concrete Substrates: Mechanically abrade concrete surfaces to a uniform profile according to ASTM D 4259. Do not acid etch.

   1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
   2. Remove concrete fins, ridges, and other projections.
   3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
   4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

3.3 TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written recommendations.

B. Provide sealant cants at penetrations and at reinforced and non-reinforced, deck-to-wall butt joints.

## 3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

## 3.5 TRAFFIC COATING APPLICATION

A. Apply traffic coating material according to ASTM C 1127 and manufacturer's written recommendations.

1. Verify that wet film thickness of each component coat complies with requirements every 100 sq. ft.

B. Apply traffic coatings to prepared wall terminations and vertical surfaces to a height of 0’-6”, and omit aggregate on vertical surfaces.

C. Cure traffic coatings according to manufacturer's written recommendations. Prevent contamination and damage during application and curing stages.

## 3.6 FIELD QUALITY CONTROL

A. Final Traffic Coating Inspection: Arrange for traffic coating manufacturer's technical personnel to inspect membrane installation on completion.

1. Notify Architect, Engineer and Owner 48 hours in advance of date and time of inspection.

## 3.7 PROTECTING AND CLEANING

A. Protect traffic coatings from damage and wear during remainder of construction period.

B. Clean spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

**SECTION 072110- SPRAYED FOAM 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 SECTION INCLUDES

A. Spray polyurethane foam (SPF) insulation.

B. Thermal barrier (fire resistive) material or coating.

1.3 REFERENCES

A. ASTM C 1029 – Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation

B. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

C. ASTM D 1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.

D. ASTM D 1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.

E. ASTM D 2856 - Standard Test Method for Open-Cell Content of Rigid Cellular Plastics by the Air Pycnometer.

F. ASTM E 119 – Standard Test Methods for Fire Test of Building Construction Materials

G. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

H. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.

I. NFPA 259 (UBC 26-1) Standard Test Method for Potential Heat of Building Materials

J. Alliance for the Polyurethanes Industry Bulletin AX-119 - MDI-Based Polyurethane Foam Systems: Guidelines for Safe Handling and Disposal, Alliance for the Polyurethanes Industry, American Plastics Council.

1.4 SUBMITTALS

A. Product Data: Manufacturer's data on products to be installed.
   1. Application or installation instructions.
   2. Listing, classification, and approval certifications.
   3. Safety and handling instructions for storage, handling and use of the materials.

B. Product Certification: Spray Polyurethane Foam Alliance accreditation program documentation for materials.

C. Certifications: If manufacturer's published data sheets do not indicate compliance with all specification requirements, provide letter of certification that all products comply with the specification requirements; include primers (if required), foam, vapor retarder and thermal barriers.

D. Applicator's Field Quality Control Procedures: Written description of procedures to be utilized to insure proper preparation and installation of foam, vapor retarder thermal barriers, detail work and follow-up inspection.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm with experience installing insulation systems of the type specified.
   1. Approved or certified by the foam manufacturer as qualified to install the specified system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide materials packaged in the manufacturer's original, tightly sealed containers or unopened packages, clearly labeled with the manufacturer's name, product identification, safety information, and batch or lot numbers where appropriate. Where materials are covered by a referenced specification, the labels shall bear the specification number, type and class, as applicable.

B. Store materials out of the weather and out of direct sunlight in locations where the temperatures are within the limits specified by the manufacturer.

1.7 PROJECT CONDITIONS

A. Comply with the manufacturer's instructions and industry recommendations as to handling and safety procedures.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Product: In accordance with the requirements provide BASF Corporation Spraytite 178 Series Insulation or an equivalent product by the following:
   1. Dow Chemical Company

2.2 MATERIALS

A. Foam: sprayed-in-place two-component closed-cell polyurethane made by combining an isocyanate (A) component with a polyol (B) component, with the following physical characteristics:

1. Density in Place: 1.88 to 2.35-lb/cu ft, when tested in accordance with ASTM D 1622.
2. Compressive Strength: 30 to 35 psi, when tested in accordance with ASTM D 1621.
3. Closed Cell Content: >90%, when tested in accordance with ASTM D 2856.
4. R-Value: Aged >6.5 per inch, when tested in accordance with ASTM C 518.
5. Permeance: 1.8-2.8 perm-inch, when tested in accordance with ASTM E-96.
6. Flame Spread Index: Less than 25, when tested in accordance with ASTM E 84.
7. Smoke Developed Index: Less than 450, when tested in accordance with ASTM E 84.

B. Thermal Barrier: Gypsum Board OR Sprayed-in-place cementitious materials (W.R. Grace Zonolite 3306) or Sprayed-in-place cellulose fiber (International Cellulose Ure-K), or or prayed-in-place mineral fiber (Ammerock) applied to achieve fire resistance rating of 15 minutes over spray polyurethane foam (SPF)

C. Primers: (if required): —The primer to be applied must be specifically selected for the given
substrate to be primed and must be compatible with the spray polyurethane foam.
1. Wood: chlorinated rubber, modified alkyds, others.
2. Steel: modified alkyds, epoxy, acrylics, others (typically including rust inhibitors).
3 Galvanized: vinyl copolymer acrylic, “vinyl wash primer”, modified alkyds, others.
4. Concrete/masonry: chlorinated rubber, vinyl copolymer acrylic, asphaltic, other.

PART 3 EXECUTION

3.1 GENERAL

A. Comply with the instructions and recommendations of the foam and other material manufacturers.

B. Familiarize all installers with correct and safe application and handling procedures:
1. See API Bulletin AX-119, "MDI-Based Polyurethane Foam Systems: Guidelines for Safe Handling and Disposal."
2. Refer to appropriate Materials Safety Data Sheets (MSDS) for additional safety information.

3.2 PREPARATION

A. Primed Steel: If the surface is free of loose scale, rust, weathered or chalking paint, it can be cleaned using vacuum equipment and hand or power tools to remove loose dirt. Remove oil, grease, form release agents, laitance, and other contaminants using proper cleaning solutions.

B. Previously Painted Steel: Clean using hand or power tools to remove loose scale and dirt. Remove oil, grease, form release agents, laitance, and other contaminants using proper cleaning solutions.

C. Galvanized Steel and Unpainted Steel: Clean as recommended by primer manufacturer.

D. Ferrous Metal: Sandblast iron and steel surfaces , which are not primed, shop painted, or otherwise protected in accordance with SSPC SP-6. Remove loose rust and unsound primer from shop-primed iron and steel surfaces by scraping or wire brushing.

E.

F. If metal surface is free of loose scale, rust, weathered or chalking paint, clean using compressed air jet, vacuum equipment, and hand or power broom to remove loose dirt. Remove grease, oil and other contaminants using proper cleaning solutions.

G. New Concrete: Allow to cure for twenty-eight (28) days prior to the application of primer or foam, and loose dirt and any other contaminants removed.

H. Remove loose dirt, dust and debris by using compressed air, vacuum equipment or brooming. Remove oil, grease, form release agents, laitance, and other contaminants using proper cleaning solutions. Do not wash wood or porous materials with water.

I. Grout, tape, or calk all joint openings that exceed 1/4 inch (6 mm) in width.

J. Prime all metal as recommended by manufacturer.

K. Prime all concrete surfaces.

3.3 FOAM APPLICATION

A. Do not begin application of foam until all preparation requirements have been completed.

B. Do not apply foam when the temperature is below that specified by the manufacturer for ambient air and substrate. Do not apply foam when temperature is within 5 degrees F (3 degrees C) of dew point.

C. Apply foam in accordance with the manufacturers specifications and processing guidelines.

D. Apply foam to a 2 inch thickness, with pass thickness of 1/2 inch (13 mm) to 2 inches (50 mm). Allow cooling time between 15-30 minutes between passes.

3.4 THERMAL BARRIER APPLICATION

A. Where indicated provide a 15-minute rated thermal barrier

B. Apply thermal barrier over entire surface of foam in accordance with manufacturer guidelines.

C. Allow thermal barrier to cure. Inspect for defects and repair defects prior to subsequent coats.

**END OF SECTION**

**SECTION 072413- EXTERIOR FINISH SYSTEM (EFS)**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes an exterior non loadbearing cladding system comprised of the following:
   1. Exterior finish system (EFS).
   2. Exterior sheathing.
   3. Cold formed metal framing, furnished under this section and installed in accordance with the requirements of Section 5 “Cold Formed Metal Framing”.

1.3 SYSTEM DESCRIPTION

A. Finish System shall consist of base coat with reinforcing mesh and finish applied over a substrate

1.4 PERFORMANCE REQUIREMENTS

A. At a minimum the Finish System Products shall be tested as follows:

   1. ASTM B 117: Salt Spray Resistance- 300 hours, no deleterious effects.
   2. ASTM C 297 Bond Strength. Failure in the substrate
   3. ASTM D 968Abrasion Resistance- 500L (132 gal), no deleterious effects
   4. ASTM 3273 Mildew Fungus Resistance- Passed.
   5. ASTM E 84 Flame Spread- Flame Spread Index less than 25, Smoke Developed less than 250.
   6. ASTM E 96 Water Vapor Transmission- Vapor Permeable.
   7. ASTM G 23 Accelerated Weathering- 2000 hour, Passed

B. Exterior Finish System Design shall be designed in accordance with the following

   1. Structural Performance: EFS shall withstand the effects of the of the minimum wind loads prescribed in ASCE 7.
   2. Deflection Limits: Sheathing and cold formed metal framing shall not exceed L/360
   3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature Change (Range): 100 deg F.

## 1.5 SUBMITTALS

A. Product Data: For each type and component of Exterior Finish System indicated.

B. Shop Drawings: Include plans, elevations, sections, details of components, details of penetration and termination, flashing details, joint locations and configurations

D. Submit placing drawings prepared and stamped by licensed professional engineers in the State of Wisconsin for framing members showing size and gauge designations, number, type, location and spacing. Indicate supplemental strapping, bracing, splices, bridging, accessories and details required for proper installation.

E. Samples for Verification: 24-inch- square panels for each type of finish-coat color and texture indicated, prepared using same tools and techniques intended for actual work including

F. Compatibility and Adhesion Test Reports: For joint sealants from sealant manufacturer indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

G. Maintenance Data

## 1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain Exterior Finish System from single source from single EFS manufacturer and from sources approved by EFS manufacturer as compatible with system components.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.

B. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.

## 1.8 PROJECT CONDITIONS

A. Weather Limitations: Maintain ambient temperatures above 40 deg F for a minimum of 24 hours before, during, and after adhesives or coatings are applied. Do not apply EFS adhesives or coatings during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EFS to be

applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide Cement Board MD Finish System as manufactured by Dryvit Systems Inc or an equivalent product by one of the following:
   1. Degussa Wall Systems, Inc.
   2. Master Wall, Inc.
   3. Omega Products International, Inc.
   4. Sto Corp.
   5. Stuc-O-Flex International, Inc.
   6. TEC; an H. B. Fuller company.

### 2.2 MATERIALS

A. Compatibility: Provide fasteners, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by EIFS manufacturer for Project.

B. Sheathing Board Substrate:
   1. Exterior Cement Board: Not less than 1 / 2- inch thick, fiber cement board complying with ASTM C 1186, Type A, for exterior applications.

C. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multi-end strands with retained mesh tensile strength of not less than 120 lbf/in. per ASTM E 2098; complying with ASTM D 578 and the following:

   1 Detail mesh: 4.3 oz/sq yd 9-1/2 inches wide.

   2 Standard Mesh: 4.3 oz/sq yd 9-1/2 inches wide.

D. Base-Coat Materials: EFS manufacturer's standard mixture complying with one of the following:

   1. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
   2. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
   3. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
   4. Factory-mixed noncementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.

E. Finish-Coat Materials: Manufacturer's standard acrylic-based coating with enhanced mildew resistance complying with the following:

1. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
2. Colors: As selected by Architect from manufacturer's full range.

F. Water: Potable.

G. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.
1. Control Joint: Prefabricated, one-piece V profile; designed to relieve stress of movement.

## 2.3 MIXING

A. General: Comply with Exterior Finish Systems manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by EFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EFS manufacturer or discard.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Exterior Finish System.

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

1. Begin coating application only after surfaces are dry.
2. Application of coating indicates acceptance of surfaces and conditions.

## 3.2 PREPARATION

A. Protect contiguous work from moisture deterioration and soiling caused by application of Exterior Finish System. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.

## 3.3 COLD FORMED METAL FRAMING INSTALLATION

A. Cold Formed Metal Framing: Install in accordance with the requirements of Section 5 “Cold Formed Metal Framing”.

3.4 EXTERIOR SHEATHING-BOARD INSTALLATION

A. Exterior Sheathing Board: Install on metal framing to comply with manufacturer's written instructions.

3.5 INSTALLATION, GENERAL

A. Comply with ASTM C 1397 and Manufacturer's written instructions for installation of Exterior Finish system as applicable to each type of substrate indicated.

3.6 TRIM INSTALLATION

A. Trim: Apply trim accessories where indicated, according to manufacturer's written instructions.

3.7 BASE-COAT INSTALLATION

A. Base Coat: Apply in minimum thickness recommended by manufacturer, but not less than 1/16-inch dry-coat thickness.

B. Reinforcing Mesh: Embed type indicated below in wet base coat to produce wrinkle-free installation with mesh continuous at corners and overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EFS manufacturer's written instructions. Do not lap reinforcing mesh within 8 inches (204 mm) of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.

1. Standard reinforcing mesh: install over the entire sheathing board.
2. Detail reinforcing mesh: installed at all sheathing board joints and inside and outside corners

3.8 FINISH-COAT INSTALLATION

A. Finish Coat: Apply over dry base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.

1. Texture**:** As selected by Architect from manufacturer's full range.

3.9 CLEANING AND PROTECTION

A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EFS coatings.

END OF SECTION 072413

## SECTION 075323 ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

## 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. Selective roof tear off to accommodate new roof top equipment and penetrations
   2. Temporary roofing
   3. Loosely laid and ballasted EPDM membrane
   4. Roof insulation.
   5. Roof pavers.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

A. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.

   1. Base flashings and membrane terminations.

C. Manufacturer Certificate: Signed by roofing manufacturer certifying that membrane roofing system complies with requirements specified in "Performance Requirements" Article.

   1. Submit evidence of complying with performance requirements.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

E. Maintenance Data: For membrane roofing system to include in maintenance manuals.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

B. Source Limitations: Obtain components of membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

## 1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

B. Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so Owner's operations will not be disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.

C. Coordinate work activities daily with Owner so Owner can place protective dust or water leakage covers over sensitive equipment or furnishings, shut down HVAC or -detection equipment if needed, and evacuate occupants from below the work area.

1.9 WARRANTY

A. All new roofing work shall be in accordance with the requirements of the owners current existing roof warranty with Carlisle SynTec Incorporated. Inspections by roofing manufacturer for approval of roofing work is required to ensure that the existing roofing warranty remain's in effect upon completion of work under this section.

**PART 2 - PRODUCTS**

2.1 TEMPORARY ROOFING MATERIALS

A. Design and selection of materials for temporary roofing are the responsibility of Contractor.
   1. Temporary roofing materials will be required to provide a waterproof seal and conform with current NCRA standards

2.2 EPDM MEMBRANE ROOFING

A. EPDM: ASTM D 4637, Type I, non-reinforced uniform, flexible EPDM sheet.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carlisle SynTec Incorporated.
   2. Thickness: 60 mils, nominal.
   3. Exposed Face Color: Black

2.3 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.

B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.

C. Bonding Adhesive: Manufacturer's standard water based.

D. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film. Membrane field seams shall be completed utilizing Factory Applied Seam Tape.

E. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.

F. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

G. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel bars, approximately 1 by 1/8 inch thick; with anchors.

H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.

I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

## 2.4 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by EPDM membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class I, Grade 3, felt or glass-fiber mat facer on both major surfaces with an aged thermal resistance R-value of 6 for each inch of thickness.

## 2.5 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

B. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

## 2.6 AGGREGATE BALLAST

A. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:

1. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone.
2. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
3. Install ballast at a minimum rate of 10 lbs./s.f.

## 2.7 WALKWAYS

A. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, with top edges beveled 3/16 inch, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:

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. Hanover Architectural Products.
b. Rapid Building Systems.
c. Roofblok Limited.
d. Sunny Brook Pressed Concrete.
e. Wausau Tile, Inc.; Terra-Paving Division.
f. Westile Roofing Products.

2. Size: 24 by 24 inches. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
3. Weight: 24 lb/sq. ft..
4. Compressive Strength: 6500 psi, minimum.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protect existing membrane roofing system that is indicated not to be reroofed.
   1. Limit traffic and material storage to areas of existing roofing membrane that have been protected.
   2. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.

B. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

C. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

D. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

E. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

### 3.2 ROOF TEAR-OFF

A. General: Roof tear off shall be minimized. Area of tear off will be limited to areas as required to accommodate roof top equipment and support framing.

B. Notify Owner each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.

C. Roof Tear-Off: Remove existing roofing pavers, membrane and other membrane roofing system components down to the deck including fasteners through deck. Salvage ballast for re-use

## 3.3 TEMPORARY ROOFING MEMBRANE

A. Install approved temporary roofing membrane over area to be reroofed.

B. Remove temporary roofing membrane before installing new roofing membrane.

## 3.4 EXAMINATION PRIOR TO INSTALLATION OF NEW ROOF

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
2. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
3. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
4. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.

Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.5 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

a. Install insulation to thicknesses required so the new roof membrane aligns with existing adjacent membrane surfaces that are to remain. The pitch of the insulation shall match the pitch of adjacent existing insulation that is to remain.

C. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

D. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

E. Loosely Laid Insulation: Loosely lay insulation units over substrate.

## 3.6 LOOSELY LAID AND BALLASTED MEMBRANE ROOFING INSTALLATION

A. Loosely lay membrane roofing over area to receive roofing according to roofing system manufacturer's written instructions.

B. Apply membrane roofing with side laps shingled with slope of deck where possible.

C. Seam Installation: Shall be in accordance with manufacturers requirements in order to maintain the roofing warranty.

D. Leave seams uncovered until inspected by membrane roofing system manufacturer.

E. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

F. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

G. Aggregate Ballast: Apply salvaged ballast uniformly over membrane roofing at the rate required by membrane roofing system manufacturer

## 3.7 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and a dhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

C. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

## 3.8 WALKWAY INSTALLATION

A. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 1 inch of space between adjacent roof pavers.

## 3.9 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

B. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

## 3.10 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for

deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

END OF SECTION

## SECTION 076200 - SHEET METAL FLASHING AND TRIM

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following sheet metal flashing and trim:

1. Roof flashing.
2. Counterflashing.
3. Roof penetrations.

1.3 PERFORMANCE REQUIREMENTS

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

C. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include the following:

1. Identify material, thickness, weight, and finish for each item and location in Project.

2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.

3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.

C. Samples for Initial Selection: For each type of sheet metal flashing and trim indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

1.7 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

**PART 2 - PRODUCTS**

2.1 SHEET METALS

A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
2. Surface: Smooth, flat.
3. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

b. Color: as selected by architect from manufacturers standard range

2.2 UNDERLAYMENT MATERIALS

A. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft.

## 2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating.

2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.

3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

4. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

C. Solder for Zinc-Tin Alloy-Coated Stainless Steel: ASTM B 32, 100 percent tin.

D. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethanepolymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

## 2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

1. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

D. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual"for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

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

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding

rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.

2. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.

D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and butyl sealant.

E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

1. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.

H. Seal joints with butyl sealant as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

## 3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal roof flashing and trim to comply with performance requirements, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.

1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 16-inch centers.

C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for butyl sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with butyl sealant.

3.4 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

**SECTION 078100 - SPRAY-APPLIED FIRE RESISTIVE MATERIALS**

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 Sprayed-Applied Fire-Resistive Materials (SFRMs).

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Framing plans, schedules, or both, indicating the following:

1. Extent of fireproofing for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3. Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of fireproofing after application.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Product Certificates: For each type of fireproofing.

C. Evaluation Reports: For fireproofing, from ICC-ES.

D. Preconstruction Test Reports: For fireproofing.

E. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

## 1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on fireproofing.

1. Provide test specimens and assemblies representative of proposed materials and construction.

B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.

1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
2. Density: Test for density according to ASTM E 605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

## 1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 40 deg F 4.4 deg C or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours prior to, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing a minimum 4 complete air exchanges per hour and according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

C. Hazardous Materials are present in the building. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
1. Hazardous material remediation in this building is being executed under a separate contract with City of Milwaukee DPW.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials

3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

## PART 2 - PRODUCTS

### 2.1 MATERIALS, GENERAL

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fireproofing from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119/UL 263 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction.

E. Low-Emitting Materials: Fireproofing used within the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Asbestos: Provide products containing no detectable asbestos.

### 2.2 SPRAY-APPLIED FIRE RESISTIVE MATERIALS

A. SFRM: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application or conveyed in a dry state and mixed with atomized water at place of application.

B. Products: Subject to compliance with requirements, provide one of the following:
1. Concealed/Commercial SFRMs:
   a. Isolatek International; CAFCO® 300 SB, CAFCO® BLAZE-SHIELD® II
   b. W. R. Grace Co. Retroguard RG
   c. Physical Properties:
      1) Bond Strength: Minimum 150-lbf/sq. ft. (7.18-kPa) cohesive and adhesive strength based on field testing according to ASTM E 736.
      2) Density: Not less than 15 lb/cu. ft. (240 kg/cu. m) as specified in the approved fire-resistance design, according to ASTM E 605.
      3) Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design.

4) Combustion Characteristics: When tested in accordance with ASTM E 136 shall be noncombustible.
5) Surface-Burning Characteristics: When tested in accordance with ASTM E84 or CAN4-S102, the material shall exhibit the following surface burning characteristics:
   a) Flame Spread Index [10] or less
   b) Smoke Developed [10] or less
6) Compressive Strength: When tested in accordance with ASTM E761, the material shall not deform more than 10 percent when subjected to a crushing force of 750 psf (35.9 kPa).
7) Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
8) Deflection: No cracking, spalling, or delamination according to ASTM E 759.
9) Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
10) Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours according to ASTM E 859.
11) Fungal Resistance: When tested in accordance with ASTM G21, the material shall show resistance to mold growth for a minimum period of 28 days with or without the use of a mold inhibitor.

## 2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:

1. Fireproofing manufacturer shall be contacted for procedures on handling primed/painted steel.
2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E 736.

C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fireproofing manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive fireproofing.

E. Reinforcing Fabric: Glass or carbon fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fireproofing manufacturer.

F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.

G. Sealer: If required, a transparent-drying, water-dispersible, tinted protective coating as recommended by fireproofing manufacturer.

H. Topcoat: If required, a topcoat suitable for application over applied fireproofing; of type recommended by fireproofing manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:

1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
2. Clips, hangers, supports, sleeves and other attachments to the substrate are to be placed by others prior to the application of the fireproofing materials.
3. The installation of ducts, piping, conduit or other suspended equipment shall not take place until the application of the fireproofing is complete in an area.

B. Fire protection shall not be applied to steel floor decks prior to the completion of concrete work on that deck.

C. The application of fireproofing to the underside of roof deck shall not commence until the roof is completely installed and tight, all penthouses are complete, all mechanical units have been placed, and construction roof traffic has ceased. When roof traffic is anticipated, as in the case of periodic maintenance, roofing pavers shall be installed as a walkway to distribute loads.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

### 3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.

B. Clean substrates of substances that could impair bond of fireproofing.

C. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

## 3.3 APPLICATION

A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.

1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.

D. Metal Decks:

1. Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, has been completed.
2. Do not apply fireproofing to underside of metal roof deck until roofing has been completed; prohibit roof traffic during application and drying of fireproofing.

E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

F. Spray apply fireproofing to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.

G. Extend fireproofing in full thickness over entire area of each substrate to be protected.

H. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.

I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fireproofing that differs in color from that of encapsulant over which it is applied.

J. Lap new Spray Applied Fire Resistive Materials (SFRM) over existing SFRM where the two systems adjoin. Install and lap new metal lath over existing SFRM and spray apply new SFRM. Installation shall be done in accordance with manufacturers requirements.

K. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.

L. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.

M. Cure fireproofing according to fireproofing manufacturer's written recommendations.

N. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.

O. Finishes: Where indicated, apply fireproofing to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.
2. Spray-Textured Finish: Finish left as spray-applied with no further treatment.

## 3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC, 1704.10.

2. For reference, utilize AWCI - Inspection Procedure for Field-Applied Sprayed Fire-Resistive Materials, Technical Manual 12-A; an annotated guide.

B. Test and inspect completed work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fireproofing will be considered defective if it does not pass tests and inspections.

1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

## 3.5 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Protect fireproofing, according to advice of manufacturer and installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.

C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

D. Repair fireproofing damaged by other work before concealing it with other construction.

E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

## 3.6 FIRE RATING SCHEDULE

Fire Resistive Rating (time in hours) Schedule shall be as follows:

| **Structural Component** | **Hourly Rating Requirement** | **Design Reference** |
|---|---|---|
| Beams | 2 hours | N759, N782 |
| Floor Assemblies | 2 hours | D759, D739 |
| Columns | 2 hours | X 790, X772 |

END OF SECTION 078100

**SECTION 07 84 13- PENETRATION FIRESTOPPING**

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 through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

B. Related Sections include the following:

1. See also Plumbing, Fireprotection, HVAC, and Electrical Sections specifying fire-suppression piping penetrations, duct and piping penetrations and conduit penetrations.

1.3 PERFORMANCE REQUIREMENTS

A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop 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 construction penetrated.

1. Fire-resistance-rated walls including fire walls, fire partitions, fire barriers, and smoke barriers.
2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.

B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings required, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

## 1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

C. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:

1. Types of penetrating items.
2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

D. Qualification Data: For Installer.

E. Product Certificates: For through-penetration firestop system products, signed by product manufacturer.

F. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."

B. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.

C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:

1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:

    a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
    b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:

        1) UL in its "Fire Resistance Directory."

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

C. Hazardous Materials are present in the building. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   1. Hazardous material remediation in this building is being executed under a separate contract with City of Milwaukee DPW.
   2. Do not disturb hazardous materials or items suspected of containing hazardous materials
   3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

1.8

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers:

   1. Specified Technologies, Inc.
   2. Hilti, Inc.
   3. 3M; Fire Protection Products Division.

4. Tremco; Sealant/Weatherproofing Division.

## 2.2 FIRESTOPPING, GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:

    a. Slag-/rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves (if cast into structural slab, very material is compatible with “Cathodic Protection” system specified in section 26 42 00).

## 2.3 FILL MATERIALS

A. General: Provide through-penetration firestop systems containing the types of fill materials referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.

B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket. If metallic components are cast into structural slab, verify material is compatible with “Cathodic Protection” system specified in section 26 42 00.

C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

H. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

I. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.

J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
3. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

## 2.4 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.

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

### 3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

### 3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

## 3.4 IDENTIFICATION

A. Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:

1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Through-penetration firestop system designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop system manufacturer's name.
6. Installer's name.

## 3.5 FIELD QUALITY CONTROL

A. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

## 3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial

Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

**END OF SECTION**

## 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes joint sealants for the applications indicated in the Joint-Sealant Schedule at the end of Part 3

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Sealant compatibility and adhesion test reports.
   1. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

D. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

B. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
   1. Locate test joints as directed by Architect.
   2. Conduct field tests for each application indicated below:
      a. Each type of elastomeric sealant and joint substrate indicated.
      b. Each type of nonelastomeric sealant and joint substrate indicated.

3. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
4. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
5. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

## 1.6 PROJECT CONDITIONS

A. 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. Hazardous Materials are present in the building. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   1. Hazardous material remediation in this building is being executed under a separate contract with City of Milwaukee DPW.
   2. Do not disturb hazardous materials or items suspected of containing hazardous materials
   3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

## 1.7 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include 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. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### 2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Immersion in Liquids. Where elastomeric sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247 and qualify for the length of exposure indicated by reference to ASTM C 920 for Class 1 or 2. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Single-Component Neutral-Curing Silicone Sealant ES-1 :
   1. Available Products:
      a. Dow Corning Corporation; 795
      b. GE Silicones; SilPruf NB SCS9000.
      c. Tremco; Spectrem 3.
   2. Type and Grade: S (single component) and NS (nonsag).
   3. Class: 50 .
   4. Use Related to Exposure: NT (nontraffic).
   5. Stain-Test-Response Characteristics: nonstaining to porous substrates per ASTM C 1248.

E. Single component Semi-Self Leveling Urethane Sealant ES-2:
   1. Available Products:
      a. Tremco; Vulkem 45 SSL.
      b. Sonneborn, Division of ChemRex Inc.; SL 1

2. Type and Grade: S (single component)
3. Class: 25.
4. Use Related to Exposure: T ( traffic).

F. Siliconized Interior Latex Acrylic Sealant ES-3 :
1. Available Products:
   a. Pecora Corporation AC-20
   b. Tremflex 834.
2. Use Related to Exposure: NT (nontraffic).
3. Stain-Test-Response Characteristics: non-staining to porous substrates per ASTM C 1248.

## 2.4 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are non-staining; 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. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin); O (open-cell material); B (bicellular material with a surface skin) and as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

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 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. Porous joint substrates include the following:

    a. Concrete, cast-in-place and precast.
    b. Masonry.
    c. Wood

3. Remove laitance and form-release agents from concrete.
4. Clean 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. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.

B. Joint Priming: Prime joint substrates where recommended in writing by joint-sealant manufacturer. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

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. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support 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.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings 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.

G. 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.
4. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

## 3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed elastomeric sealant joints as follows:
   a. Perform 1 test for each 1000 feet of joint length

2. Test Method: Test joint sealants as appropriate for type of joint-sealant application indicated.

   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; do this by extending cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field-adhesion-test log.
4. Inspect tested joints and report on the following:

   a. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
   b. Whether sealants filled joint cavities and are free of voids.
   c. Whether sealant dimensions and configurations comply with specified requirements.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

## 3.5 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.

## 3.6 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.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior vertical joints between plant precast architectural concrete units

1. Joint Sealant: Single Component silicone sealant, ES-1.
2. Joint-Sealant Color: As selected by Architect from manufacturer's full range

B. Joint-Sealant Application: Exterior vertical joints at perimeter of window and storefront systems.

1. Joint Sealant: Single component silicone sealant, ES-1.
2. Joint-Sealant Color: As selected by Architect from manufacturer's full range

C. Joint-Sealant Application: Exterior vertical joints at wall components not indicated above

1. Joint Sealant: Single component silicone sealant, ES-1.
2. Joint-Sealant Color: As selected by Architect from manufacturer's full range

D. Joint-Sealant Application: horizontal traffic joints in concrete slabs on grade

1. Joint Sealant: Self-leveling urethane sealant, ES-2.
2. Joint-Sealant Color: As selected by Architect from manufacturer's full range

E. Joint-Sealant Application: Interior vertical joints in CMU and drywall partition framing

1. Joint Sealant: Siliconized interior latex acrylic sealant, ES-3.

F. Joint-Sealant Color: As selected by Architect from manufacturer's full range

END OF SECTION

## SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hollow Metal Doors and Frames.

2. Fire-rated hollow metal door and frame assemblies.

1.3 DEFINITIONS

A. Steel Sheet Thicknesses: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic-coated steel sheets.

1.4 SUBMITTALS

A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.

B. Shop Drawings: Show the following:

1. Elevations of each door design.

2. Details of doors including vertical and horizontal edge details.

3. Frame details for each frame type including dimensioned profiles.

4. Details and locations of reinforcement and preparations for hardware.

5. Details of each different wall opening condition.

6. Details of anchorages, accessories, joints, and connections.

7. Coordination of glazing frames and stops with glass and glazing requirements.

C. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

D. Oversize Construction Certificates: For door assemblies required to be fire-protection rated and exceeding size limitations of labeled assemblies.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252UBC Standard 7-2 or UL 10C.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.

C. Store doors and frames at building site under cover. Place units on minimum 4-inch- high wood blocking. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following Steel Door Institute members:

1. Hollow Metal Doors and Frames:

a. Ceco Door Products.

b. Curries Company.

c. Kewanee.

d. Republic Doors and Frames

e. Steelcraft.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 (ZF120) G60 (Z180) metallic coating.

C. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

E. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

F. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

G. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. (96- to 192-kg/cu. m) density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

## 2.3 STANDARD HOLLOW METAL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.

1. Design: Flush panel
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.

   a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
   b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

      1) Locations: Exterior doors and interior doors where indicated.

3. Vertical Edges for Single-Acting Doors: Square or Beveled edge.

   a. Beveled Edge: 1/8 inch in 2 inches.
4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

## 2.4 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated from metallic-coated steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as full profile welded unless otherwise indicated.
3. Frames for Level 3 Steel Doors: 0.067-inch- thick steel sheet.

C. Interior Frames: Fabricated from cold-rolled steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as full profile welded unless otherwise indicated.
3. Frames for Level 2 Steel Doors: 0.053-inch- thick steel sheet.
4. Frames for Wood Doors: 0.053-inch- thick steel sheet.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

E. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.

F. Plaster Guards: Provide 0.016-inch- thick, steel sheet plaster guards or mortar boxes to close off interior of openings; place at back of hardware cutouts where mortar or other materials might obstruct hardware operation.

## 2.5 ACCESSORIES

A. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- (6.4-mm-thick by 25.4-mm-) wide steel.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

## 2.6 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

   a. Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
      1) Four anchors per jamb from 90 to 120 inches high.

   b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
      1) Five anchors per jamb from 90 to 96 inches high.
      2) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches high.
      3) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.

   c. Compression Type: Not less than two anchors in each jamb.
   d. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door

Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.7 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250..

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. At fire-protection-rated openings, install frames according to NFPA 80.
b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
c. Install frames with removable glazing stops located on secure side of opening.
d. Install door silencers in frames before grouting.
e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
6. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
7. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

    a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
    b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
    c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
    d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

## 3.2 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION

**SECTION 087100 - DOOR HARDWARE**

**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. Commercial door hardware for the following:

a. Swinging doors.

2. Cylinders for doors specified in other Sections.

B. Related Sections include the following:

1. Division 08 Section "Steel Doors and Frames

C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1. Cylinders for locks specified in other Sections.

D. Bidding Requirements.

1. Proposals shall be based on specified manufacturers and products indicated in Paragraph 3.7 Door Hardware Sets or equivalent products by other manufacturers specified in this section.

1.3 SUBMITTALS

A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples for Verification: Submit minimum 2-by-4-inch plate Samples of each type of finish required, except primed finish.

C. Other Action Submittals:

1. Door Hardware Sets: detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
   a. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
   b. Content: Include the following information:

      1) Identification number, location, hand, fire rating, and material of each door and frame.
      2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device
      3) Complete designations of every item required for each door or opening including name and manufacturer.
      4) Fastenings and other pertinent information.
      5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
      6) Explanation of abbreviations, symbols, and codes contained in schedule.
      7) Mounting locations for door hardware.
      8) Door and frame sizes and materials.

      9) List of related door devices specified in other Sections for each door and frame.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

## 1.4 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

## 1.5 COORDINATION

A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.6 WARRANTY

A. Provide 5 year manufacturer warranty.

1.7 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

**PART 2 - PRODUCTS**

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.

2.2 HINGES

A. Quantity: Provide the following, unless otherwise indicated:
   1. Three Hinges: For doors with heights 61 to 90 inches.
   2. Four Hinges: For doors with heights 91 to 120 inches.
   3. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

B. Butt Hinge size requirements: Unless otherwise indicated, provide the following:

   1. Interior doors up to 37” wide: 4 1/2 x 4 1/2.
   2. Interior doors over 37” wide: 5 x 4 1/2.
   3. Exterior Doors: 5 x 4 1/2.

C. Door Butt Hinge Basis of Design (unless otherwise noted in Schedule):

   1. Full Mortise Hinge BB1279 (Hager) or equal.

D. Hinge Base Metal: Unless otherwise indicated, provide the following:
   1. Interior Hinges: Stainless steel, with stainless-steel pin.

E. Available Manufacturers:
   1. Bommer Industries, Inc. (BI).
   2. Hager Companies (HAG).
   3. McKinney Products Company; an ASSA ABLOY Group company (MCK).
   4. PBB Mfg, Inc. (PBB)

## 2.3 LOCKS AND LATCHES, GENERAL

A. Accessibility Requirements: Comply with accessibility requirements, comply with ANSI A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.

B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

C. Mortise Locksets:
1. Case: Wrought Steel
2. Levers: Cast or Wrought.
   a. Basis of Design: Lever- 07, L-Series, with Rose "A" as Manufactured by Schlage Lock Company
3. (Roses): Wrought.

D. Backset: 2-3/4 inches, unless otherwise indicated.
1. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set.

E. Verify all lock functions with owner.

1. Available Manufacturers:
   a. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).
   b. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
   c. Dorma Architectural Hardware (DOR)

## 2.4 LOCK CYLINDERS

A. Standard Lock Cylinders: Same manufacturer as for locks and latches.

B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Number of Pins: Six.
2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.

C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:

D. Construction Keying: Comply with the following:

1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 1 construction master keys.

E. Available Manufacturers:
   1. Match Owners Existing Lock System

## 2.5 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:

   1. Grand Master Key System: Cylinders to be operated by owners grand master key.
   2. Keys: Nickel silver.

   3. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

      a. Notation: "DO NOT DUPLICATE."

   4. Quantity: In addition to one extra key blank for each lock, provide the following:

      a. Cylinder Change Keys: Two
      b. Master Keys: Two.
      c. Grand Master Keys: Two.

## 2.6 OPERATING TRIM

A. Materials: Fabricate from bronze, unless otherwise indicated.

B. Available Manufacturers:
   1. Hager Companies (HAG).
   2. Hiawatha, Inc. (HIA).
   3. IVES Hardware; an Ingersoll-Rand Company (IVS).
   4. Rockwood Manufacturing Company (RM).
   5. Trimco Manufacturing Company (TRI)

## 2.7 CLOSERS

A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply ANSI A117.1.

   1. Comply with the following maximum opening-force requirements:

      a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.

B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.

C. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

D. Surface Closers: Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.

1. Available Manufacturers:
   a. LCN Closers; an Ingersoll-Rand Company (LCN).
   b. Sargent Lock Company (SAR)
   c. Dorma Architectural Hardware (DOR)

## 2.8 STOPS AND HOLDERS

A. Stops and Bumpers:

1. Provide wall stops for doors unless floor or other type stops are scheduled or indicated.

2. Install wall stop behind doors.

3. Install wall stops using expansion shields and machine screws

B. Silencers for Wood Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum 5/8 by 3/4 inch; fabricated for drilled-in application to frame.

C. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame.

D. Available Manufacturers:

1. Architectural Builders Hardware Mfg., Inc. (ABH).
2. Trimco Manufacturing Company (TRI)
3. Hager Companies (HAG).
4. Hiawatha, Inc. (HIA).

## 2.9 DOOR GASKETING

A. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

B. Air Leakage: Not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.

C. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

D. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

E. Gasketing Materials: ASTM D 2000 and AAMA 701/702.

F. Available Manufacturers:

1. Hager Companies (HAG).
2. National Guard Products (NGP).
3. Pemko Manufacturing Co. (PEM).
4. Reese Enterprises (RE).

## 2.10 THRESHOLDS

A. Accessibility Requirements: Where thresholds are indicated comply with accessibility requirements, comply with ANSI A117.1.

B. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch high.

C. Available Manufacturers:

1. Hager Companies (HAG).
2. National Guard Products (NGP).
3. Pemko Manufacturing Co. (PEM).
4. Reese Enterprises (RE).

## 2.11 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Steel Machine or Wood Screws: For the following fire-rated applications:

    a. Mortise hinges to doors.
    b. Strike plates to frames.
    c. Closers to doors and frames.

3. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:

    a. Surface hinges to doors.
    b. Closers to doors and frames.
    c. Surface-mounted exit devices.

4. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
5. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.12 FINISHES

A. Standard: BHMA A156.18, as indicated in door hardware sets.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

### 3.2 PREPARATION

A. Steel Doors and Frames: Comply with DHI A115 Series.

1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

B. Wood Doors: Comply with DHI A115-W Series.

### 3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights as follows unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

## 3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

## 3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

DOOR HARDWARE SCHEDULE

DOOR HARDWARE SET 1

| Qty | Description | Model | Manufacturer | Finish |
|---|---|---|---|---|
| 3 | Butts | | Hager | US32D |
| 1 | Lock | L9080 | Schlage | US32D |
| 1 | Overhead Stop | GJ410 | Glynn Johnson | US32D |

DOOR HARDWARE SET 1A

| Qty | Description | Model | Manufacturer | Finish |
|---|---|---|---|---|
| 3 | Butts | | Hager | US32D |
| 1 | Lock | L9070 | Schlage | US32D |
| 1 | Overhead Stop | GJ410 | Glynn Johnson | US32D |

DOOR HARDWARE SET 2

| Qty | Description | Model | Manufacturer | Finish |
|---|---|---|---|---|
| 3 | Butts | | Hager | US32D |
| 1 | Lock | L9080 | Schlage | US32D |
| 1 | Closer | 4110H Cush | LCN | Powdercoat |
| 1 | Wall Stop | 402/405 | Rockwood | US32D |
| 3 | Jamb Seal | 161UA | NGP | |
| 1 | Threshold | 442-5 | NGP | Clear Anod. |
| 1 | Sweep | B606 | NGP | |

DOOR HARDWARE SET 3

| Qty | Description | Model | Manufacturer | Finish |
|---|---|---|---|---|
| 1 | Bi Fold Door Hardware | | Stanley | US32D |
| 1 | Pull | 1-inch diameter 8” CTC | Rockwood | US32D |

DOOR HARDWARE SET 4

| Qty | Description | Model | Manufacturer | Finish |
|---|---|---|---|---|
| 3 | Butts | | Hager | US32D |
| 1 | Lock | L9080 | Schlage | US32D |
| 1 | Closer | 4110 Cush | LCN | Powdercoat |

END OF SECTION

## SECTION 092116 - GYPSUM BOARD SHAFT-WALL ASSEMBLIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes gypsum board shaft-wall assemblies for the following:

1. Shaft-wall enclosures.
2. Horizontal enclosures.

### 1.3 SUBMITTALS

A. Product Data: For each gypsum board shaft-wall assembly indicated.

### 1.4 QUALITY ASSURANCE

A. Fire-Resistance Ratings: Provide materials and construction identical to those of assemblies with fire-resistance ratings determined according to ASTM E 119 by a testing and inspecting agency.

B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, and 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 panels flat on leveled supports off floor or slab to prevent sagging.

### 1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

1. American Gypsum Company.
2. G-P Gypsum.
3. Lafarge North America Inc.
4. National Gypsum Company.
5. USG Corporation.
6. Approved Equal

### 2.2 GYPSUM BOARD SHAFT-WALL ASSEMBLIES, GENERAL

A. Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.

1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
2. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.

### 2.3 PANEL PRODUCTS

A. Gypsum Liner Panels: Comply with ASTM C 442/C 442M.

1. Moisture- and Mold-Resistant Type X: Manufacturer's proprietary liner panels with moisture- and mold-resistant core and surfaces; comply with ASTM D 3273.

a. Core: 1 inch thick.
b. Long Edges: Double bevel.

B. Water-Resistant Gypsum Backing Board: As specified in Division 9 Section "Gypsum Board Assemblies."

C. Cementitious Backer Units: As specified in Division 9 Section "Gypsum Board Assemblies."

## 2.4 NON-LOAD-BEARING STEEL FRAMING

A. Framing Members: Comply with ASTM C 754 for conditions indicated.

B. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.

1. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized.

## 2.5 AUXILIARY MATERIALS

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

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Division 9 Section “Gypsum Board" that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.

C. Gypsum Board Joint-Treatment Materials: As specified in Division 9 Section "Gypsum Board."

D. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum face-layer panels to backing-layer panels in multilayer construction.

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

F. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.

1. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

G. Sound Attenuation Blankets: 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.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

H. Acoustical Sealant: Manufacturers proprietary acoustical sealant

## 2.6 GYPSUM BOARD SHAFT-WALL ASSEMBLIES

A. Basis-of-Design Product: As indicated on Drawings by design designation of a qualified testing agency.

B. Sustained Air Pressure Loads: 5 lb/sq. ft.

C. Deflection Limit: L/240.

D. Fire-Resistance Rating: As indicated

E. STC Rating: 51 minimum, unless indicated otherwise

F. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.

1. Depth: As indicated.
2. Minimum Base-Metal Thickness: Manufacturers standard thicknesses that comply with structural performance requirements for stud depth indicated, unless indicated otherwise.

G. Runner Tracks: Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches long and in depth matching studs.

1. Minimum Base-Metal Thickness: Matching steel studs

H. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of 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.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Dietrich Metal Framing; The System by Metal-Lite, Inc.
b. Fire Trak Corp.; Fire Trak

I. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches in depth matching studs, and not less than 0.0329 inch thick.

J. Room-Side Finish: Gypsum board (unless noted otherwise).

K. Shaft-Side Finish: As indicated by fire-resistance-rated assembly design designation.

L. Insulation: Sound attenuation blankets.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates to which gypsum board shaft-wall assemblies attach or abut, with Installer present, including hollow-metal frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.

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

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

## 3.2 INSTALLATION

A. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:

1. ASTM C 754 for installing steel framing except comply with framing spacing indicated.
2. Division 9 Section “Gypsum Board" for applying and finishing panels.

B. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.

1. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with 0.0312-inch minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 face-layer panel.

C. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

D. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.

E. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

F. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect, while maintaining fire-resistance rating of gypsum board shaft-wall assemblies.

G. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C 919 requirements or with manufacturer's written instructions, whichever are more stringent.

H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

## 3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and 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

## SECTION 092900 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior gypsum wallboard.

2. Exterior gypsum wallboard

3. Non-load-bearing steel framing.

B. Related Sections include the following:

1. Division 5 Section "Cold Formed Metal Framing" for framing gypsum wallboard at locations indicated.

2. Division 9 Section "Gypsum Board Shaft-Wall Assemblies" for framing, gypsum panels, and other components of shaft wall assemblies.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

A. Product Data: For each type of product indicated..

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."

B. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.

1. STC-Rated Assemblies: Indicated by design designations from GA-600, "Fire Resistance Design Manual."

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. Stack gypsum panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

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

1. Steel Framing and Furring:

a. Consolidated Systems, Inc.

b. Dale Industries, Inc. - Dale/Incor.

c. Dietrich Industries, Inc.

d. National Gypsum Company.

e. Approved Equal.

2. Gypsum Board and Related Products:

a. American Gypsum Co.

b. G-P Gypsum Corp.

c. National Gypsum Company.

d. United States Gypsum Co.

e. Gypsum Board and Related Products.

2.2 STEEL SUSPENDED CEILING AND SOFFIT FRAMING

A. Components, General: Comply with ASTM C 754 for conditions indicated.

B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.

C. Hanger Attachments to Concrete: As follows:

1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.

D. Hangers: As follows:

1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

E. 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, G60, hot-dip galvanized zinc coating.

1. Depth: 2 inches.

F. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base Metal Thickness: 0.0179 inch, unless indicated otherwise

b. Configuration: Asymmetrical or hat shaped, with face attached to single flange by a slotted leg (web) or attached to two flanges by slotted or expanded metal legs .

G. Grid Suspension System for Interior Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Armstrong World Industries, Inc.; Furring Systems/Drywall.

b. Chicago Metallic Corporation; Fire Front 630 System.

c. USG Interiors, Inc.; Drywall Suspension System.

d. Approved Equal.

2.3 STEEL PARTITION AND SOFFIT FRAMING

A. Components, General: As follows:

1. Comply with ASTM C 754 for conditions indicated. (Maximum Deflection: L/240)

2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

B. Steel Studs and Runners: ASTM C 645.

1. Minimum Base Metal Thickness: Manufacturers standard thicknesses, or as indicated on drawings, that comply with structural performance requirements for stud depths indicated.

2. Depth: As indicated .

C. Proprietary Deflection Track: Steel sheet top runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs.

1. Product: Subject to compliance with requirements, provide one of the following:

a. Delta Star, Inc., Superior Metal Trim; Superior Flex Track System (SFT).

b. Metal-Lite, Inc.; Slotted Track.

c. Approved Equal.

D. Proprietary Firestop 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.

1. Product: Subject to compliance with requirements, provide one of the following:

a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.

b. Metal-Lite, Inc.; The System.

c. Approved Equal.

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base Metal Thickness: 0.0179 inch.

F. Cold-Rolled Channel Bridging: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange.

1. Depth: As indicated .

2. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch- thick, galvanized steel.

G. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: 0.0179 inch.

2. Depth: As indicated .

H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

I. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

## 2.4 GYPSUM BOARD, GENERAL

A. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site.

B. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

## 2.5 INTERIOR GYPSUM WALLBOARD

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

B. Gypsum Wallboard: ASTM C 36.

1. Regular Type:

a. Thickness: 5/8 inch.

b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

c. Location: Vertical surfaces, unless otherwise indicated.

2. Type X:

a. Thickness: 5/8 inch.

b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

c. Location: Vertical surfaces, unless otherwise indicated.

C. Sag-Resistant Gypsum Wallboard: ASTM C 36, manufactured to have more sag resistance than regular-type gypsum board.

1. Thickness: 1/2 inch.

2. Long Edges: Tapered.

3. Location: Ceiling surfaces.

2.6 EXTERIOR GYPSUM BOARD

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

B. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Custom Building Products; Wonderboard.

b. FinPan, Inc.; Util-A-Crete Concrete Backer Board.

c. United States Gypsum Co.; DUROCK Cement Board.

d. Approved Equal.

2. Thickness: 1/2 inch.
3. Mold Resistance: ASTM D 3273, score of 10.

2.7 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized steel sheet.

2. Shapes:

a. Cornerbead: Use at outside corners.

b. LC-Bead: J-shaped; exposed long flange receives joint compound; use at exposed panel edges.

c. L-Bead: L-shaped; exposed long leg receives joint compound; use where indicated.

d. Expansion (Control) Joint: Use where indicated.

e. Curved-Edge Cornerbead: With notched or flexible flanges; use at curved openings.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Fry Reglet Corp.

b. Gordon, Inc.

c. Pittcon Industries

d. Approved Equal.

2.8 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.

2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.

3. Tile Backing Panels: As recommended by panel manufacturer.

C. 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, rounded or 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.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.

4. Finish Coat: For third coat, use setting-type, sandable topping compound.

5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

D. Joint Compound for Exterior Applications:

1. Glass-Mat Gypsum Sheathing Board: As recommended by manufacturer.

E. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by manufacturer.

2.9 ACOUSTICAL SEALANT

A. Products: Subject to compliance with requirements, provide one of the following:

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.

c. Approved Equal.

2. Acoustical Sealant for Concealed Joints:

a. Ohio Sealants, Inc.; Pro-Series SC-170 Rubber Base Sound Sealant.

b. Pecora Corp.; BA-98.

c. Tremco, Inc.; Tremco Acoustical Sealant.

d. Approved Equal.

2.10 AUXILIARY MATERIALS

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

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

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

1. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Isolation Strip at Exterior Walls:

1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

E. Sound Attenuation Blankets: 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.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

F. Thermal Insulation: As specified in Division 7 Section "Building Insulation."

G. Polyethylene Vapor Retarder: As specified in Division 7 Section "Building Insulation."

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

3.2 PREPARATION

A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.

3.3 INSTALLING STEEL FRAMING, GENERAL

A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.

B. 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."

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.

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. Use deep-leg deflection track where indicated.

b. Use proprietary firestop track where indicated.

D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.4 INSTALLING STEEL SUSPENDED CEILING AND SOFFIT FRAMING

A. 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, counters playing, 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. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye screws, 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. Secure rod, flat and angle hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.

5. Do not attach hangers to steel deck tabs.

6. Do not attach hangers to steel roof deck. Attach hangers to structural members.

7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.

C. Sway-brace suspended steel framing with hangers used for support.

D. Wire-tie furring channels to supports, as required to comply with requirements for assemblies indicated.

E. 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.

F. 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.

3.5 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.

1. Where studs are installed directly against exterior walls, install foam-gasket isolation strip between studs and wall.

B. 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.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. 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 and STC-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. Terminate partition framing at suspended ceilings where indicated.

D. Install steel studs and furring at the following spacing:

1. 16 inches o.c., unless otherwise indicated.

E. 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.

F. 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.

G. 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.

H. Z-Furring Members:

1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches o.c.

2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

4. Until gypsum board is installed, hold insulation in place with 10-inch staples fabricated from 0.0625-inch- diameter, tie wire and inserted through slot in web of member.

I. Polyethylene Vapor Retarder: Install to comply with requirements specified in Division 7 Section "Building Insulation."

3.6 APPLYING AND FINISHING PANELS, GENERAL

A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board 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. 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. Form control and expansion joints with space between edges of adjoining gypsum panels.

I. 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 open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.

J. 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 U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

K. STC-Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.

L. 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.

M. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.

3.7 PANEL APPLICATION METHODS

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.

2. On partitions/walls, apply gypsum panels horizontally (perpendicular 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.

b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

B. Multilayer Application on Ceilings: Apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

C. 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 or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

1. Z-Furring Members: Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

D. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

E. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.

F. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

G. Exterior Panels:

1. Cementitious Backer Units: ANSI A108.11.

3.8 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. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

3.9 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, 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, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, 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: Embed tape at joints in 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: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated.

3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

END OF SECTION

**SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS**

PART 1 - GENERAL

1.1 SUMMARY

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

B. This Section includes acoustical tiles and concealed suspension systems for ceilings.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each exposed finish.

C. Maintenance data.

1.3 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory.

B. Fire-Test-Response Characteristics:

1. Surface-Burning Characteristics: Acoustical tiles complying with ASTM E 1264 for Class A materials, when tested per ASTM E 84.

a. Smoke-Developed Index: 450 or less.

PART 2 - PRODUCTS

2.1 ACOUSTICAL TILE CEILINGS, GENERAL

A. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

1. Size: Select wire diameter so its stress at 3 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.

B. Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements;

formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

## 2.2 ACOUSTICAL TILES FOR ACOUSTICAL TILE CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide the products indicated on the Material Schedule on the Drawings or a comparable product by the following:

1. USG Interiors, Inc.
2. Certainteed Corp.

B. Exposed Perimeter Trim: Manufacturer's standard perimeter trim, no larger than 4-1/2" high.

C. Modular Size: As indicated on Drawings.

## 2.3 METAL SUSPENSION SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide the products indicated on the Material Schedule on the Drawings or a comparable product by the following:

1. USG Interiors, Inc.
2. Certainteed Corp.
3. Chicago Metallic

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders.

C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
2. Do not attach hangers to steel deck tabs or to steel roof deck.

D. Install edge moldings and trim at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles. 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.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Exposed Perimeter Trim: At all locations where tile does not intersect wall surfaces, provide manufacturer's standard perimeter trim.

G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.

END OF SECTION

## SECTION 09 65 19- RESILIENT FLOORING, BASE AND ACCESSORIES

## PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Tile.
   2. Wall Base.
   3. Molding accessories.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Samples: Two (2) for each type of product indicated, in manufacturer's standard-size samples of each resilient product color, texture, and pattern required.

1.3 PROJECT CONDITIONS

A. Maintain temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. After post-installation period, maintain temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

2.1 COLORS AND PATTERNS

A. Colors and Patterns: as indicated.

2.2 RESILIENT WALL BASE

A. Manufacturers: As indicated on Drawings.

B. Type (Material Requirement): Rubber, thermoplastic.

C. Style: As indicated on Drawings.

D. Minimum Thickness: 0.125 inch.

E. Height: 4 inches.

F. Lengths: Coils in manufacturer's standard length.

G. Outside Corners: Job formed.

H. Inside Corners: Job formed.

I. Surface: Smooth.

2.3 RESILIENT TILE

A. Products: Manufacturer as indicated on Drawings.

B. Material: Vinyl composition.

C. Style: As indicated on Drawings.

D. Installation Method: Adhesive.

E. Traffic-Surface Texture: As indicated on Drawings.

F. Size: 12" x 12” square.

G. Thickness: Minimum .125"

H. Weight: Per product as indicated on Drawings.

I. Color and Pattern: As indicated on Drawings.

2.4 RESILIENT MOLDING ACCESSORY

A. Description: Included, but not limited to carpet edge for glue-down applications, nosing for resilient floor covering, reducer strip for resilient floor covering, joiner for tile and carpet.

B. Material: Rubber.

C. Profile and Dimensions: As indicated provide applicable profile between dissimilar materials.

2.5 INSTALLATION MATERIALS

A. Trowel-able Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturers for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

## PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.

B. Verify that concrete floors are ready for installation by testing for moisture emission rate and alkalinity. Obtain instructions and notify architect immediately if test results are not within specified limits. Do not begin installation if test results are not within specified limits.

1. Moisture emission rate: Not greater than 3 lbs. per 1,000 sq. ft. per 24 hours when tested using calcium chloride moisture test kit fro 72 hours.

2. Alkalinity: pH range of 5-9.

C. Beginning of installation means acceptance of existing substrate and site conditions.

D. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

E. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.

F. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

1. Do not install resilient products until they are the same temperature as the space where they are to be installed.

G. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RESILIENT WALL BASE INSTALLATION

A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

D. Do not stretch wall base during installation.

E. On masonry surfaces or other similar irregular substrates, fill voids along top edge of wall base with manufacturer's recommended adhesive filler material.

F. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.

2. Inside Corners: Use straight pieces of maximum lengths possible. Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.

3.3 RESILIENT TILE AND ACCESSORY INSTALLATION

A. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor coverings that would otherwise be exposed.

B. Resilient Tile: Comply with manufacturer's written instructions and recommendations.

C. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

G. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing resilient product installation:

1. Remove adhesive and other blemishes from exposed surfaces.

2. Sweep and vacuum surfaces thoroughly.

3. Damp-mop surfaces to remove marks and soil.

a. Do not wash surfaces until after time period recommended by manufacturer.

B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

**END OF SECTION**

**SECTION 096813- CARPET TIIE**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes new carpet tile and installation of new and salvaged tile carpeting.

B. Related Sections include the following:

1. Division 9 Section "Resilient Tile Flooring Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation methods.

B. Shop Drawings: Show the following:

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Tile Carpet: Full-size Samples (2 required).

2. Exposed Edge Stripping and Accessory: 12-inch-long Samples.

D. Product Schedule: Use same room and product designations indicated on Drawings and in schedules.

E. Maintenance Data: For carpet tile to include in maintenance manuals specified in Division 1. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.

2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with CRI 104, Section 5, "Storage and Handling."

1.6 PROJECT CONDITIONS

A. General: Comply with CRI 104, Section 6.1, "Site Conditions; Temperature and Humidity."

B. Environmental Limitations: Do not install carpet tile until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Do not install carpet tile over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tile, install carpet tile before installing these items.

1.7 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Carpet Tile Warranty: Written warranty, signed by carpet tile manufacturer agreeing to replace carpet tile that does not comply with requirements or that fails within specified warranty period. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.

1. Warranty Period: 10 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 CARPET TILE PRODUCTS

A. Products: See Room Finish Schedule on drawings for basis of manufacturers product. Other acceptable manufacturers are listed contingent upon matching all aesthetic and performance characteristics as approved by Architect.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided by or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and that is recommended by carpet tile manufacturer.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Verify that substrates and conditions are satisfactory for carpet tile installation and comply with requirements specified.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:

1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.

2. Subfloor finishes comply with requirements specified in Division 3 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.

3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.

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

3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 13, "Carpet Modules (Tiles)."

B. Installation Method: Glue-down; install every tile with releasable adhesive.

C. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

F. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.

2. Remove yarns that protrude from carpet tile surface.

3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI 104, Section 15, "Protection of Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

**END OF SECTION**

**SECTION 096816- SHEET CARPETING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes new sheet carpeting, and installation of new and salvaged sheet carpeting.

B. Related Sections include the following:

1. Division 9 Section "Resilient Tile Flooring Base and Accessories" for resilient wall base and accessories installed with carpet.

1.3 SUBMITTALS

A. Product Data: For the following, including installation recommendations for each type of substrate:

1. Carpet: For each type indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance.

B. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet: 2-foot x 2-foot Samples (2 required).
2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- long Samples.

C. Product Schedule: Use same room and product designations indicated on Drawings and in schedules.

D. Maintenance Data: For carpet tile to include in maintenance manuals specified in Division 1. Include the following:

1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.

2. Precautions for cleaning materials and methods that could be detrimental to carpet.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with CRI 104, Section 5, "Storage and Handling."

1.6 PROJECT CONDITIONS

A. General: Comply with CRI 104, Section 6.1, "Site Conditions; Temperature and Humidity."

B. Environmental Limitations: Do not install carpet until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Do not install carpet over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.7 WARRANTY

A. Special Warranty for Carpet: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, and delamination.
3. Warranty Period: 10 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 CARPET PRODUCTS

A. Products: See Room Finish Schedule on drawings for carpet products.
1. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided by or recommended by carpet and cushion manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and cushion and that is recommended by carpet and cushion manufacturers.

C. Tackless Carpet Stripping: Water-resistant plywood, in strips as required to match cushion thickness and that comply with CRI 104, Section 12.2.

D. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

E. Metal Edge Strips: as indicated on drawings, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:

1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet and cushion manufacturer.
2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet.
3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.

### 3.2 PREPARATION

A. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet manufacturer.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

### 3.3 INSTALLATION

A. Comply with CRI 104 and carpet and carpet cushion manufacturers' written installation instructions for the following:

1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."

B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

C. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.

D. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

F. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.

## 3.4 CLEANING AND PROTECTING

A. Perform the following operations immediately after installing carpet:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
2. Remove yarns that protrude from carpet surface.
3. Vacuum carpet using commercial machine with face-beater element.

B. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."

C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer.

**END OF SECTION**

**SECTION 09 91 00 - PAINTING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and field painting of the following:

1. Exposed exterior items and surfaces.
2. Exposed interior items and surfaces.
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. Paint 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.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:
   a. Finished mechanical and electrical equipment.
   b. Light fixtures.
   c. Distribution cabinets.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

   a. Foundation spaces.
   b. Furred areas.
   c. Ceiling plenums.

3. Finished metal surfaces include the following:

   a. Anodized aluminum.
   b. Stainless steel.

c. Chromium plate.
d. Copper.
e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:

a. Valve and damper operators.
b. Linkages.
c. Sensing devices.
d. Motor and fan shafts.

5. 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.

## 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 5 and 20 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 30 and 65 when measured at a 60-degree meter.
5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

## 1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each finish and for each color and texture required.

C. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

## 1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers, 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 of each type of coating and substrate required on the Project. Comply with procedures specified in PDCA P5. Duplicate finish of approved prepared samples.

1. The 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 on at least 100 sq. ft. of wall surface.
   b. Small Areas and Items: The Architect will designate an item or area as required.

2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface according to the Schedule or as specified. Provide required sheen, color, and texture on each surface.

   a. After finishes are accepted, the Architect will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from job-applied samples.

## 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. Remove oily rags and waste daily. 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 water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when the 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.

1.8 MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.

1. Quantity: Furnish the Owner with an additional 2 gallons of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide products noted in the paint schedule.

2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and 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 paint material of the various coating types specified. 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. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: Provide custom colors of the finished paint systems to match the Architect's samples.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.

1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify the Architect about anticipated problems 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 the 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 the substrates of substances that could impair the 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. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

    a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
    b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.

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 the Steel Structures Painting Council's (SSPC) recommendations.

    a. Blast steel surfaces clean as recommended by paint system manufacturer and according to requirements of SSPC-SP 10.

b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.

4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Materials 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.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

## 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 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, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
5. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.

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 the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer on metal surfaces that have been shop primed and touchup painted.
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 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, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:

1. Piping, pipe hangers, and supports.
2. Ductwork.
3. Insulation.
4. Accessory items.

G. Electrical items to be painted include, but are not limited to, the following:

1. Conduit and fittings.

H. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the 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.

I. 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.

J. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

## 3.4 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the 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. Comply with procedures specified in PDCA P1.

3.6 Basis-of-Design Product: Paint systems in this specification are listed to establish a standard of quality. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Diamond Vogel
2. ICI Paints North America
3. Benjamin Moore & Co
4. Hallman Lindsay Quality Paints
5. Pratt & Lambert Paints
6. Mautz Paints
7. Sherwin Williams (S-W)

## 3.7 EXTERIOR PAINT SCHEDULE

A. Steel (including steel doors and frames, guardrails and miscellaneous metal components) 2 Coat:

1. 1 coat primer if un-primed or spot prime if factory primed; according to metal type.
   SW Pro Cryl Universal Primer, B66-310 series, applied at a spreading rate recommended by manufacturer to achieve a dry film thickness not less than 1.2 mils.
2. 1 coat – SW 0 VOC Acrylic, B66-650 series, applied at a spreading rate recommended by manufacturer to achieve a dry film thickness not less than 2.6 mils
3. Provide 2 finish coats at hollow metal doors and frames.

## 3.8 INTERIOR PAINT SCHEDULE

A. Concrete (Other than Concrete Masonry Units): Provide the following paint systems over interior concrete surfaces:

1. Semi-Gloss, Acrylic-Enamel Finish: 2 finish coats.

a. First and Second Coats: Semi-gloss, Vinyl Acrylic Block filler and Finish coat System. Basis of Design Sherwin Williams, ProMar 200 B25W35 or an approved equal from the list below.

B. Steel (including steel doors and frames, exposed structural columns and other miscellaneous metal components) 2 Coat:
1. 1 coat primer if un-primed or spot prime if factory primed; according to metal type. SW Pro Cryl Universal Primer, B66-310 series, applied at a spreading rate recommended by manufacturer to achieve a dry film thickness not less than 1.2 mils.
2. 1 coat – SW 0 VOC Acrylic, B66-650 series, applied at a spreading rate recommended by manufacturer to achieve a dry film thickness not less than 2.6 mils
3. Provide 2 finish coats at hollow metal doors and frames.

C. Gypsum Board, Latex, 3 Coat:
1. 1coat – Pro-Green 200 Primer, B28W600, applied at a spreading rate recommended by manufacturer to achieve a dry film thickness not less than 1.2 mils.
2. 2 coats – SW Pro-Green 200 Egg Shell, B31-600 Series, applied at a spreading rate recommended by manufacturer to achieve a dry film thickness not less than 1.6 mils per coat.

D. Concrete Masonry Units: Provide the following finish systems over interior concrete masonry block units:
1. Low-Luster, Acrylic-Enamel Finish: 2 finish coats over a block filler.
   a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 5.0 mils. Sherwin Williams: Prep- Rite B25 W25
   b. First and Second Coats: Acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils. Sherwin Willams: Promar 200.

END OF SECTION

## SECTION 101400 - SIGNAGE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes the following sign assemblies:
   1. Aluminum dimensional characters as indicated on drawings with a 2 inch deep return; support stanchions and anchors that secure the signage to the exterior wall cladding of the PAB .
   2. Aluminum panel sign with adhesive backed die cut vinyl faced graphics that replicate the Milwaukee Police Department Shield; support stanchions and anchors that secure the sign to the exterior wall cladding of the PAB .

### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for signs.

   1. Show sign mounting heights, locations of supplementary supports to be provided under this section for the support of the signs and accessories.

C. Samples: For each sign type and for each color and texture required.

D. Comprehensive engineering analysis and calculations of the signage support connections signed and sealed by the qualified professional engineer, licensed in the State of Wisconsin, responsible for its preparation.

### 1.3 QUALITY ASSURANCE

A. Structural Performance: Provide signs, anchors, and connections, capable of withstanding the following design loads:
   1. Design Loads: in accordance the requirements of the “Design Table” on drawing S100.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.

C. Applied Vinyl: Die-cut graphics from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing, suitable for exterior applications.

## 2.2 DIMENSIONAL CHARACTERS

A. Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated. Comply with the following requirements.

B. Aluminum Extrusions: Comply with the following requirements:

1. Finish: Clear Anodized.
2. Thickness: 1/8-inch thick.
3. Mounting: Concealed studs non-corroding for substrates encountered.

## 2.3 PANEL SIGNS

A. Exterior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
1. Aluminum Plate- 1/8 inch thick.
   a. Finish: Clear Anozided
2. Mounting: Unframed
3. Projection mounted.
   a. Manufacturer's standard non-corroding anchors for substrates encountered.
4. Adhesive backed acrylic sheet with graphics and text replicating City of Milwaukee Police Department Shield

B. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory paint brackets in color matching background color of panel sign .

## 2.4 ACCESSORIES

A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

## 2.5 FABRICATION

A. General: Provide manufacturer's standard signs of configurations indicated.

1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
3. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: Manufacturer's standard Class 1 clear anodic coating, 0.018 mm or thicker, over a satin directionally textured mechanical finish, complying with AAMA 611.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.

1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.

B. Coordinate sign mounting details with manufacturer of new exterior wall panels where sign will be attached to new exterior wall panels. Anchor points and method of attachment require written approval by manufacturer of exterior wall panels.

C. Sign Mounting-
1. Mount characters at projection distance of 4-inches from the exterior wall surface.

END OF SECTION 101400

# SECTION 14 21 00 - ELECTRIC TRACTION ELEVATORS

## 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 making modifications to existing electric traction passenger and service elevators to comply with high rise code requirements.

B. Related Sections include the following:

1. Division 02 Section "Selective Demolition”.
2. Division 26 Sections for modifications to power for elevators to and including fused disconnect switches and standby power source, transfer switch, and connection from auxiliary contacts in transfer switch to controller.
3. Division 28 Section "Fire Detection and Alarm" for smoke detectors in elevator lobbies to initiate emergency recall operation, fireman’s phones in elevator cabs, and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.

### 1.3 DEFINITIONS

A. Definitions in ASME A17.1 apply to work of this Section.

B. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

C. Service Elevator: A passenger elevator that is also used to carry freight.

### 1.4 SUBMITTALS

A. Product Data/shop drawings: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include information on the following:

1. Modifications to Car enclosures for fireman’s phones.
2. Modifications to control system.
3. Elevator control panel.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for service/modifications of existing units required for this Project.

B. Source Limitations: Obtain service through one source from a single manufacturer.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.

B. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

## 1.7 COORDINATION

A. Coordinate installation with other trades contractors on project.

B. Coordinate sequence of elevator installation with other work to avoid delaying the Work.

## 1.8 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 OPERATION SYSTEMS

A. General: Program existing microprocessor operation system for each elevator/for each group of elevators as required providing type of operation indicated.

B. Group Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators and elevator groups:

1. Standby Power Operation: On activation of standby power, cars are returned to a designated floor and parked with doors open. One car is returned at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at fire command center. Manual operation causes automatic operation to cease.

2. Standby Power Operation: On activation of standby power, cars are returned, one at a time, to a designated floor and parked with doors open. If a car cannot be returned, it is removed from the system. When all cars have been returned or removed from the system, one car can be put in service on standby power by a selector switch in control panel located at fire command center.

## 2.2 SIGNAL EQUIPMENT

A. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section "Fire Detection and Alarm."

B. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.

C. Fire Command Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed. Provide Phase 1 Emergency Recall manual activation switches.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine existing elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator and associated work is to be completed.

## 3.2 INSTALLATION

A. Comply with manufacturer's written instructions.

## 3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.

B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

## 3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate elevator(s). Refer to Division 01 Section "Demonstration and Training."

B. Check operation of each elevator and associated fire command center controls with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

END OF SECTION 142100

## SECTION 21 05 00 - FIRE-SUPPRESSION PIPING

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:
   1. Wet-pipe sprinkler systems.

B. Related Sections include the following:
   1. Division 26 Section "Fire Alarm System" for alarm devices not specified in this Section.
   2. Division 21 Section "Electric-Drive Fire Pumps" for fire pumps, pressure-maintenance pumps, and pump controllers.

1.3 DEFINITIONS (RESERVED)

1.4 SYSTEM DESCRIPTIONS (RESERVED)

1.5 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

1.6 SUBMITTALS

A. Product Data: For the following:

   1. Piping materials, including dielectric fittings and specialty fittings.
   2. Pipe hangers and supports.
   3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
   4. Alarm devices, including electrical data.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Fire-hydrant flow test report.

D. Approved Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

E. 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" and "Contractor's Material and Test Certificate for Underground Piping."

F. Welding certificates.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For 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 fire-suppression 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: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-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 (RESERVED)

**PART 2 - PRODUCTS**

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern .
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

B. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.

1. Grooved-Joint Piping Systems:

a) Manufacturers:

1) Victaulic Co. of America.

b) Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.
c) Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, rubber gasket with center leg, and steel bolts and nuts.
d) Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with end matching ductile-iron-pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove, rubber gasket listed for use with housing, and steel bolts and nuts.
e) Grooved-End Transition Flange: UL 213, gasketed fitting with key for ductile-iron-pipe dimensions. Include flange-type, ductile-iron housing with rubber gasket listed for use with housing and steel bolts and nuts.

## 2.2 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865.

B. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll -grooved ends.

1. Grooved-Joint Piping Systems:

a) Manufacturers:
1) Central Sprinkler Corp.
2) Star Pipe Products; Star Fittings Div.
3) Victaulic Co. of America.

b) Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c) Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

C. Threaded-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe.
5. Steel Threaded Couplings: ASTM A 865.

D. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:
   1) Central Sprinkler Corp.
   2) Star Pipe Products; Star Fittings Div.
   3) Victaulic Co. of America.

   b) Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
   c) Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 DIELECTRIC FITTINGS

A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.

C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.

D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.

E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.

F. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 225 deg F.

2.4 FLEXIBLE CONNECTORS

A. Flexible connectors shall have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.
3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.

B. Manufacturers:

1. Anamet Inc.
2. Flex-Hose Co., Inc.
3. Flexicraft Industries.

4. Flex-Pression, Ltd.
5. Flex-Weld, Inc.
6. Hyspan Precision Products, Inc.
7. Mercer Rubber Co.
8. Metraflex, Inc.
9. Proco Products, Inc.
10. Unaflex Inc.

C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

## 2.5 SPECIALTY FITTINGS

A. Specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:

a) Central Sprinkler Corp.
b) Fire-End and Croker Corp.
c) Viking Corp.
d) Victaulic Co. of America.

C. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Manufacturers:

a) AGF Manufacturing Co.
b) Central Sprinkler Corp.

## 2.6 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.

2. Manufacturers:

   a) Grinnell Fire Protection.
   b) NIBCO.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3: Ductile-iron body with grooved ends.
4. Manufacturers:

   a) NIBCO.
   b) Victaulic Co. of America.

D. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.

   a) Available Manufacturers:

      1) Global Safety Products, Inc.
      2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

   a) Manufacturers:

      1) Central Sprinkler Corp.
      2) Mueller Company.
      3) NIBCO.
      4) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:
   a) Central Sprinkler Corp.
   b) Crane Co.; Crane Valve Group; Crane Valves.
   c) Grinnell Fire Protection.
   d) Mueller Company.
   e) NIBCO.
   f) Potter-Roemer; Fire Protection Div.
   g) Reliable Automatic Sprinkler Co., Inc.
   h) Star Sprinkler Inc.
   i) Victaulic Co. of America.
   j) Watts Industries, Inc.; Water Products Div.

F. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a) Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

a) Manufacturers:
1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) Milwaukee Valve Company.
4) Mueller Company.
5) NIBCO.
6) Red-White Valve Corp.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, 2-circuit, supervisory switch Visual.
2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.

a) Manufacturers:

1) Milwaukee Valve Company.
2) NIBCO.
3) Victaulic Co. of America.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

a) Manufacturers:

1) Central Sprinkler Corp.
2) Grinnell Fire Protection.
3) Milwaukee Valve Company.
4) NIBCO.
5) Victaulic Co. of America.

## 2.7 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

## 2.8 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

1. Manufacturers:
   a) Central Sprinkler Corp.
   b) Grinnell Fire Protection.
   c) Victaulic Co. of America.
   d) Viking Corp.

2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.

   a) Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

B. Pressure-Regulating Valves: UL 1468, brass or bronze, NPS 1-1/2 and NPS 2-1/2 , 400-psig minimum rating. Include female NPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as indicated.

1. Finish: Rough metal.
2. Manufacturers:
   a) Elkhart Brass Mfg. Co., Inc.
   b) Grinnell Fire Protection.
   c) Potter-Roemer; Fire Protection Div.
   d) Zurn Industries, Inc.; Wilkins Div.

## 2.9 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:
   a) Grinnell Fire Protection.
   b) ITT McDonnell & Miller.
   c) Potter Electric Signal Company.
   d) System Sensor.
   e) Viking Corp.
   f) Watts Industries, Inc.; Water Products Div.

C. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Manufacturers:

a) Grinnell Fire Protection.
b) Potter Electric Signal Company.
c) System Sensor.
d) Viking Corp.

D. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:
a) Potter Electric Signal Company.
b) System Sensor.

2.10 PRESSURE GAGES

A. Manufacturers:
1. AMETEK, Inc.; U.S. Gauge.
2. Dresser Equipment Group; Instrument Div.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" on dial face.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine existing conditions to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction.

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

3.2 PIPING APPLICATIONS, GENERAL

A. Shop weld pipe joints where welded piping is indicated.

B. Do not use welded joints for galvanized-steel pipe.

C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

3.3 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
1. NPS 2: Threaded-end, black , standard-weight steel pipe; cast iron threaded fittings; and threaded joints.
2. NPS 2: Threaded-end, threadable, thinwall steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
3. NPS 2 1/2 to NPS 8: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

## 3.4 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 .

   a) Shutoff Duty: Use ball, butterfly, or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 .

   a) Shutoff Duty: Use ball, butterfly, or gate valves.
   b) Throttling Duty: Use ball or globe valves.

## 3.5 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

D. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.

1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
2. NPS 2-1/2 to NPS 8: Use dielectric flanges.

## 3.6 PIPING INSTALLATION

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

I. Install alarm devices in piping systems.

J. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install system piping according to NFPA 13.

K. Install pressure gages on riser or feed main, at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

L. Fill wet-pipe system piping with water.

M. Install flexible connectors on fire-pump and pressure-maintenance-pump supply and discharge connections.

## 3.7 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty 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. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

## 3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

D. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

E. Electrical Connections: Power wiring is specified in Division 26.

F. Connect alarm devices to fire alarm.

G. Ground equipment according to Division 26 Section "Grounding and Bonding."

H. Connect wiring according to Division 26 Section "Conductors and Cables."

I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.9 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13

3.10 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Energize circuits to electrical equipment and devices.
4. Flush, test, and inspect piping systems according to NFPA 13, "Systems Acceptance" Chapter.
5. Coordinate with fire alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

**END OF SECTION 21 05 00**

## SECTION 21 31 00 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes electric-drive, split-case centrifugal fire pumps and the following:

1. Fullservice fire-pump controllers and automatic transfer switches.
2. Fire-pump accessories and specialties.
3. Pressure-maintenance pumps, controllers, accessories, and specialties.

### 1.3 PERFORMANCE REQUIREMENTS

A. Pump, Equipment, Accessory, Specialty, and Piping Pressure Rating: 175-psig (1200-kPa) minimum working-pressure rating, unless otherwise indicated.

### 1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, certified pump performance curves with each selection point indicated, operating characteristics, and furnished accessories and specialties for each fire pump and pressure-maintenance pump.

B. Shop Drawings: For fire pumps and drivers, fire-pump controllers, fire-pump accessories and specialties, pressure-maintenance pumps, pressure-maintenance-pump controllers, and pressure-maintenance-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.

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.

C. Product Certificates: For each type of fire pump and fire-pump controller, signed by product manufacturer.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For fire pumps and drivers, pressure-maintenance pumps, controllers, accessories and specialties, alarm panels, and flowmeter systems to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fire pumps, pressure-maintenance pumps, and controllers through one source from a single manufacturer for each type of equipment.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.

D. Comply with NFPA 20, "Stationary Pumps for Fire Protection," for fire pumps, drivers, controllers, accessories, and their installation.

1.6 COORDINATION

PART 2 - A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

**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, manufacturers offering products that may be incorporated into the Work include manufacturers specified.

2.2 CENTRIFUGAL FIRE PUMPS

A. Description, General: UL 448, factory-assembled and -tested, electric-drive, centrifugal fire pumps capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head.

1. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
2. Nameplate: Complete with capacities, characteristics, and other pertinent data.

B. Fabricate base and attachment to fire pumps, pressure-maintenance pumps, and controllers with reinforcement to resist movement of pumps and controllers during a seismic event when their bases are anchored to building structure.

C. Single-Stage, Horizontally Mounted, Split-Case Fire Pumps: Double-suction type with pump and driver mounted on same base and connected with coupling.

1. Manufacturers:

a. A-C Pump; ITT Industries.
b. Armstrong Darling, Inc.
c. Aurora Pump; Pentair Pump Group.
d. Fairbanks Morse; Pentair Pump Group.
e. Paco Pumps, Inc.
f. Patterson Pump Company.

2. Pump: Axially split cast-iron casing with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless otherwise indicated.

a. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
b. Wear Rings: Replaceable, bronze.
c. Shaft and Sleeve: Steel shaft with bronze sleeve.

1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

3. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
4. Driver: UL-listed, NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.

a. Manufacturers:

1) Emerson; U.S. Electrical Motors.
2) Lincoln Electric Company (The).
3) Marathon Electric, Inc.

## 2.3 FIRE-PUMP CONTROLLERS

A. Fire-Pump Controllers, General: UL 218 and NFPA 20; listed for electric-drive, fire-pump service and service entrance; combined automatic and manual operation; factory assembled and wired; and factory tested for capacities and electrical characteristics.

1. Manufacturers:

a. Cutler-Hammer.
b. Firetrol, Inc.
c. Hubbell Industrial Controls, Inc.

d. Joslyn Clark.
e. Master Control Systems, Inc.
f. Metron, Inc.

2. Rate controllers for scheduled fire-pump horsepower and short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.

3. Maximum starting current shall be set to 1.5 times the full load amps of the motor.
4. Enclosure: UL 50, Type 2, dripproof, indoor, unless special-purpose enclosure is indicated. Include manufacturer's standard red paint applied to factory-assembled and - tested unit before shipping.
5. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed.

   a. Isolating means and circuit breaker.
   b. "Power on" pilot lamp.
   c. Fire-alarm system connections for indicating motor running condition, loss-of-line power, and line-power phase reversal.
   d. Automatic and manual operation, and minimum run-time relay to prevent short cycling.
   e. Water-pressure-actuated switch with independent high and low calibrated adjustments responsive to water pressure in fire-suppression piping.
   f. Automatic and manual shutdown.
   g. System pressure recorder, electric ac driven with spring backup.

6. Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.
7. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous-metal sensing piping, NPS 1/2 (DN 15), with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32-inch (2.4-mm) orifice in clapper or ground-face union with noncorrosive diaphragm having 3/32-inch (2.4-mm) orifice.

B. Full-Service Fire-Pump Controllers:

1. Type Starting: Solid State Soft start..
2. Mounting: Floor-stand type for field electrical connections.
3. Automatic Transfer Switches: UL 218 and UL 1008 and requirements for and attached to fire-pump controllers. Include enclosure complying with UL 50, Type 2, with automatic transfer switch with rating at least equal to fire-pump driver-motor horsepower. Include ampere rating not less than 115 percent of motor full-load current and suitable for switching motor-locked rotor current. Provide with following features.
   a. Contacts indicating position (normal/emergency power).
   b. Contacts indicating power Source (normal/emergency).
   c. Ability to be remote controlled from the generator annunciators installed in the fire command center and substation room.

## 2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:

1. Automatic air-release valve.
2. Circulation relief valve.
3. Suction and discharge pressure gages.
4. Eccentric-tapered reducer at suction inlet.
5. Concentric-tapered reducer at discharge outlet.
6. Test-Header Manifold: Ductile-iron or brass body for hose valves. Include nozzle outlets arranged in single line; horizontal, flush-wall mounting attachment; and rectangular, polished chrome-plated brass finish escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
7. Ball Drip Valve: UL 1726.
8. Discharge Cone: Closed type.
9. Finish: Manufacturer's standard factory-applied red paint unless brass or other finish is specified.

## 2.5 PRESSURE-MAINTENANCE PUMPS

A. Pressure-Maintenance Pumps, General: Factory-assembled and -tested pumps with electric-motor driver, controller, and accessories and specialties. Include cast-iron or stainless-steel casing and bronze or stainless-steel impellers, mechanical seals, and suction and discharge flanges machined to ASME B16.1, Class 125 dimensions unless Class 250 flanges are indicated and except that connections may be threaded in sizes where flanges are not available.

1. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.
2. Nameplate: Complete with capacity, characteristics, and other pertinent data.

B. Regenerative-Turbine, Pressure-Maintenance Pumps: Close-coupled type complying with HI 1.1-1.2 and HI 1.3 requirements for regenerative-turbine centrifugal pumps. Include base.

1. Manufacturers:

   a. Aurora Pump; Pentair Pump Group.
   b. Crane Pumps & Systems, Inc.
   c. Fairbanks Morse; Pentair Pump Group.
   d. Paco Pumps, Inc.

2. Driver: NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.

C. Controllers: UL 508; factory-assembled, -wired, and -tested, across-the-line type for combined automatic and manual operation.

1. Manufacturers:

   a. Cutler-Hammer.

b. Firetrol, Inc.
c. Hubbell Industrial Controls, Inc.
d. Joslyn Clark.
e. Master Control Systems, Inc.
f. Metron, Inc.

2. Enclosure: UL 508 and NEMA 250, Type 2, wall-mounting type for field electrical wiring.

a. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.

3. Rate controller for scheduled horsepower and include the following:

a. Fusible disconnect switch.
b. Pressure switch.
c. Hand-off-auto selector switch.
d. Pilot light.
e. Running period timer.

D. Accessories and Specialties: Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:

1. Circulation relief valve.
2. Suction and discharge pressure gages.

## 2.6 PRESSURE GAGES

A. Description: UL 393, 3-1/2- to 4-1/2-inch- (90- to 115-mm-) diameter dial with range of 0- to 250-psig (0- to 1725-kPa) minimum. Include caption "WATER" on dial face.

1. Manufacturers:

a. AGF Manufacturing Co.
b. AMETEK, Inc.; U.S. Gauge.
c. Brecco Corporation.
d. Dresser Equipment Group; Instruments Div.
e. Marsh Bellofram.
f. WIKA Instrument Corporation.

## 2.7 GROUT

A. Description: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect fire pumps with their controllers according to NFPA 20 for certified shop tests.

B. Verification of Performance: Rate fire pumps according to requirements indicated.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, concrete bases, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping to verify actual locations of piping connections before fire-pump installation.

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

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for fire pumps, pressure-maintenance pumps, and controllers. Refer to Division 23 Section "Basic Mechanical Materials and Methods."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.3 INSTALLATION

A. Install and align fire pump, pressure-maintenance pump, and controller according to NFPA 20.

B. Install pumps and controllers to provide access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Set base-mounting-type pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

1. Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near anchor bolts, to provide 3/4- to 1-1/2-inch (19- to 38-mm) gap between pump base and concrete base for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Verify that coupling faces and pump suction and discharge flanges are level and plumb.

D. Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles.

E. Install valves that are same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.

F. Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.

G. Support pumps and piping separately so weight of piping does not rest on pumps.

H. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

## 3.4 ALIGNMENT

A. Align split-case fire-pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

E. Align vertically mounted, split-case pump and driver shafts after complete unit has been made plumb on concrete base, grout has set, and anchor bolts have been tightened.

## 3.5 CONNECTIONS

A. Piping installation requirements are specified in Division 13 Section "Fire-Suppression Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect water supply and discharge piping to fire pumps with flexible connectors. Connect water supply and discharge piping to pressure-maintenance pumps. Refer to Division 21 Section "Fire-Suppression Piping" for flexible connectors.

D. Connect relief-valve discharge to point of disposal.

E. Connect controllers to pumps.

F. Connect fire-pump controllers to building fire-alarm system. Refer to Division 28 Section "Fire Alarm."

G. Ground equipment according to Division 26 Section "Grounding and Bonding."

H. Connect wiring according to Division 26 Section "Conductors and Cables."

## 3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire pump performs as indicated.

C. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:

    a. Lubricate oil-lubrication-type bearings.
    b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
    c. Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
    d. Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.

3. Starting procedure for pumps is as follows:

    a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.
    b. Open sealing-liquid supply valves if pump is so fitted.
    c. Start motor.
    d. Open discharge valve slowly.
    e. Observe leakage from stuffing boxes and adjust sealing-liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately, but let packing run in before reducing leakage through stuffing boxes.
    f. Check general mechanical operation of pump and motor.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Fire hoses are for field-acceptance tests only and are not property of Owner.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps, drivers, controllers, and pressure-maintenance pumps. Refer to Division 1 Section "Closeout Procedures"

**END OF SECTION 21 31 00**

## SECTION 22 05 00 – 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 1 Specification Sections, apply to this Section.

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. Sleeves.
   5. Escutcheons.
   6. Grout.
   7. Mechanical demolition.
   8. Equipment installation requirements common to equipment sections.
   9. Painting and finishing.
   10. Concrete bases.
   11. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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 duct shafts.

D. The following are industry abbreviations for plastic materials:
   1. PVC: Polyvinyl chloride plastic.

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

1.4 SUBMITTALS (RESERVED)

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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.

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

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

D. Coordination Meetings: Attend coordination meetings with the construction manager and all other trades for the purpose of coordinating the locations of all fire protection, plumbing, HVAC and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field.

1. Conflicts Between Trades: Resolve all conflicts with other trades at no additional cost to the Owner or Architect.

E. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of fire protection, plumbing, HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.

F. This Contractor shall completely cooperate with all other trades in the matter of planning and executing of the work. Every reasonable effort shall be made to prevent conflict and interferences as to space requirements, dimensions, locations, openings, sleeving or other matters which tend to delay or obstruct the work of any trade.

1.8 INTENT OF DRAWINGS AND SPECIFICATIONS

A. These specifications and attendant drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with present practices of the trade shall not relieve the Contractor from providing such additional labor and materials.

B. The drawings depicting plumbing work are diagrammatic and show, in their approximate location, symbols representing plumbing equipment and devices. The exact location of such

equipment and devices shall be established in the field in accordance with instructions from the Architect and/or established by manufacturer's installation drawings and details.

1. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring plumbing connections to verify rough-in and connection locations.
2. Unless specifically stated to the contrary, no measurement of a plumbing drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the plumbing drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

C. The plumbing drawings do not attempt to show the complete details of building construction which affect the plumbing installation. The Contractor shall refer to plans of other trades for additional details which affect the proper installation of this work. Bring any discrepancies to the attention of the A/E for resolution. The Contractor is cautioned that diagrams showing plumbing connections and/or piping are diagrammatic only and must not be used for obtaining lineal runs of piping. Piping diagrams do not necessarily show the exact physical arrangement of the equipment

1.9 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

A. Before submitting a bid, the Contractor shall visit the site and familiarize himself with all features of the building and site, which may affect the execution of his work. No extra payment will be allowed for the failure to obtain this information. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points with the Engineer before submitting his bid. In lieu of written clarification by addendum, the contractor shall resolve all conflicts in favor of the greater quantity or better quality.

1.10 DEMOLITION, RENOVATION AND DISPOSITION OF EXISTING EQUIPMENT.

A. This Contractor shall note that the existing building will remain in service during portions of the construction period. Areas of the building will be vacated as required to facilitate construction. This Contractor shall proceed with the completion of his work in such a manner as to cause the least possible interference with the Owner's operation. All work required in the existing building shall be done in a manner and time acceptable to the Owner.

B. Plumbing equipment in conflict with construction shall be removed and/or relocated as indicated on the drawings, as directed or required. This Contractor shall remove all plumbing equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. Except for piping and miscellaneous hardware, all plumbing equipment shall remain the property of the Owner and shall be stored on the site for removal by the Owner. All other piping and equipment removed shall become the property of this Contractor and shall be removed from the site.

C. This Contractor shall be responsible for the work of other trades as may be necessary to facilitate the installation of plumbing work in the existing building. Such work necessary that is normally done by other trades and is not covered as a part of other Divisions of the work shall be done under the direction and at the expense of the Plumbing Contractor. This work shall include but is not limited to, cutting, patching, and refinishing and all necessary and required to leave existing building in condition acceptable to the Architect.

D. Any existing fixtures or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction shall be reconnected in an approved manner. In addition, any existing fixture or equipment which may

require relocation or rerouting, as a result of construction, shall be considered a part of the work of this branch and shall be done by this Contractor with no additional compensation.

E. All coring that is required for plumbing work shall be by this Contractor.

F. All equipment containing hazardous materials removed during the project become the Contractor's property and he shall dispose of them in accordance with applicable DNR and EPA regulations.

G. Piping which is to remain in service, but which is presently routed through areas being demolished shall be rerouted around demolition area.

## PART 2 - PRODUCTS

2.1 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.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 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 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 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.

D. Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 TRANSITION COUPLINGS:

A. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Unshielded, Nonpressure Transition Couplings: ASTM C 1173; elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Sleeve Materials:
   a) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

D. Shielded, Nonpressure Transition Couplings: ASTM C 1460; elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Pressure Transition Couplings: AWWA C219; corrosion-resistant metal sleeve-type with ductile iron center-sleeve and rubber gasket. Coupling shall be same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

## 2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: ASSE 1079; factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: ASSE 1079; factory-fabricated, bolted, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Nipples: IAPMO PS 66; electroplated steel nipple complying with ASTM F 1545 with inert and noncorrosive, propylene lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

## 2.5 SLEEVES

A. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS AND FLOOR PLATES

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 and spring-clip fasteners.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

D. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

E. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

F. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

G. One-Piece, Floor-Plates: Cast-iron floor plate.

H. Split-Casting, Floor-Plates: Cast brass with concealed hinge.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION**

3.1 PLUMBING DEMOLITION

A. Refer to Division 2 Sections "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 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 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. Escutcheons for New Piping: One-piece, cast-brass type with polished, chrome-plated finish, except as follows:
   a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b) Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
   c) Bare Piping in Unfinished Service Spaces and Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
2. Escutcheons for Existing Piping: Split-casting brass type with polished, chrome-plated finish, except as follows:
   a) Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
   b) Bare Piping in Unfinished Service Spaces and Equipment Rooms: Split-casting brass type with polished, chrome-plated or rough-brass finish.

M. Install floor plates for piping penetrations of equipment-room floors.

N. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.3 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.4 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.5 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. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 PIPING CONNECTIONS

A. Verify final equipment locations for roughing-in.

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

C. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

## 3.7 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. Extend grease fittings to accessible locations.

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

## 3.8 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section "Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

## 3.9 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

## 3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.11 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

**END OF SECTION**

## SECTION 22 05 23 - 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. Bronze ball valves.
   2. Iron, single-flange butterfly valves.
   3. Iron, grooved-end butterfly valves.

B. Related Sections:
   1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
   2. 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. OS&Y: Outside screw and yoke.

D. RS: Rising stem.

1.4 ACTION 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 B31.9 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 angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 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. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

### 2.2 BRONZE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ball Valves: Apollo Valves, Hammond Valve, Milwaukee Valve Company, NIBCO.
2. Gate Valves: Hammond Valve, Milwaukee Valve Company, NIBCO.

B. Bronze Ball Valves: MSS SP-110, two-or three-piece bronze body with threaded ends, chrome-plated bronze ball, PTFE or TFE seat, 600 psig minimum CWP rating and blowout-proof bronze stem.
   1. NPS 2 and smaller: Full port.
   2. NPS 2-1/2 – NPS 3: Conventional port.

2.3 IRON VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Full Lug Butterfly Valves: Hammond Valve, Milwaukee Valve Company, NIBCO, Watts.
   2. Gate Valves: Hammond Valve, Milwaukee Valve Company, NIBCO, Watts.
   3. Grooved-End Butterfly Valves: NIBCO, Victaulic.

B. Full Lug Iron Butterfly Valves: MSS SP-67, cast- or ductile-iron full lug body, rated for bi-directional dead end service at rated pressure without use of downstream flange, bubble-tight shutoff.
   1. CWP Rating: 200-psig minimum.
   2. Disc: Aluminum bronze ASTM B148
   3. Lining: EPDM lining
   4. Stem: Stainless steel stem with upper and lower alignment bearings

C. Grooved End Iron Butterfly Valves: MSS SP-67, coated ductile-iron full lug body, rated for bi-directional dead end service at rated pressure without use of downstream flange, bubble-tight shutoff.
   1. CWP Rating: 300-psig minimum.
   2. Disc: EPDM encapsulated ductile iron.
   3. Seal: EPDM.
   4. Stem: Two-piece stainless steel stem with upper and lower alignment bearings

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. 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.

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 or butterfly valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Ball, or butterfly valves.

B. Stainless steel valves with grooved ends may be used in stainless steel grooved piping in lieu of bronze or iron valves. Stainless steel valves must meet minimum performance criteria specified for bronze or iron valve.

3.5 VALVE APPLICATIONS

A. Water Supply and Return Piping:
1. Shutoff and Throttling Service:
a) NPS 2 and Smaller: Bronze two-piece ball valves.
b) NPS 2-1/2 and NPS 3: Bronze three-piece ball valves or iron butterfly valves.
c) NPS 4 and Larger: Iron butterfly valves.

**END OF SECTION**

## SECTION 22 05 29 - 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. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.

B. Related Sections:

1. Division 05 Section for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 fire-suppression piping Sections for pipe hangers for fire-suppression piping.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Cooper B-Line, Inc.
   b) Flex-Strut Inc.
   c) Unistrut Corporation; Tyco International, Ltd.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel .
7. Metallic Coating: Electroplated zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

**PART 3 - EXECUTION**

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal 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 the building structure.

B. Metal 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 for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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. Fastener System Installation: Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1. Attach clamps and spacers to piping.

   a) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c) Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. 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 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a) NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b) NPS 4: 12 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.2 METAL FABRICATIONS

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

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.3 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.

## 3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## 3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are 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 on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
4. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
5. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
6. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
7. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

I. 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 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a) Light (MSS Type 31): 750 lb.
    b) Medium (MSS Type 32): 1500 lb.
    c) Heavy (MSS Type 33): 3000 lb.
13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

**END OF SECTION**

## SECTION 22 05 53 - 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. Pipe labels.
   2. Stencils.
   3. Valve tags.

1.3 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 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.2 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

2. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

**PART 3 - EXECUTION**

3.1 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 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Painting."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.
   1. Identification Paint: Use for contrasting background.
   2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:
   1. Domestic Cold Water Piping:

a) Background Color: Dark Green.
b) Letter Color: White.

2. Domestic Hot Water and Hot Water Return Piping:

a) Background Color: Light Green.
b) Letter Color: White.

3. Sanitary Waste Drainage Piping:

a) Background Color: White.
b) Letter Color: Black.

3.3 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: 1-1/2 inches, round.
2. Letter Color: Black

**END OF SECTION**

## SECTION 22 07 19 - PLUMBING PIPING 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 insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. 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.

C. Field quality-control reports.

1.5 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing 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 agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a) One 10-foot section of NPS 2 straight pipe.
b) One each of a 90-degree threaded, welded, and flanged elbow.
c) One each of a threaded, welded, and flanged tee fitting.
d) One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
e) Four support hangers including hanger shield and insert.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.6 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.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1.8 COORDINATE CLEARANCE REQUIREMENTS WITH PIPING INSTALLER FOR PIPING INSULATION APPLICATION.

1.9 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 "Piping Insulation Schedule, General," "Indoor Piping Insulation 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. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a) Johns Manville; Microlite.
   b) Knauf Insulation; Friendly Feel Duct Wrap.
   c) Owens Corning; SOFTR All-Service Duct Wrap.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a) Johns Manville; Micro-Lok HP.
   b) Knauf Insulation; 1000-Degree Pipe Insulation with ECOSE TechnologyOwens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

## 2.3 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. Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. VOC limit for indoor applications: 80 g/L.

D. ASJ Adhesive Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. VOC limit for indoor applications: 50 g/L.

E. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. VOC limit for indoor applications: 50 g/L.

## 2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. VOC limit for indoor applications: 50 g/L.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

## 2.5 SEALANTS

A. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. VOC limit for indoor applications: 420 g/L

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.VOC limit for indoor applications: 420 g/L.

## 2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

## 2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

## 2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. 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. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. 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 piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

   a) For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. 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. Cleanouts.

## 3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. 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, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate piping and fittings that have been abated for asbestos containing materials.
3. 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.
4. 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.
5. 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.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a) Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, 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, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.10 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.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. Insulation Material: Mineral fiber
2. Insulation Thickness: 1 inch thick minimum.
3. Factory-Applied Jacket: ASJ-SSL.
4. Field-Applied Jacket: PVC on exposed piping in mechanical rooms or within 10' of floor in occupied spaces.
5. Vapor Barrier Required: Yes.

B. Domestic Hot and Recirculated Hot Water:
1. Insulation Material: Mineral fiber
2. Insulation Thickness:
   a) NPS 1-1/2 and Smaller: 1 inch thick minimum.
   b) NPS 2 and Larger: 2 inch thick minimum.
3. Factory-Applied Jacket: ASJ-SSL.
4. Field-Applied Jacket: PVC on exposed piping in mechanical rooms or within 10' of floor in occupied spaces.
5. Vapor Barrier Required: No.

C. Stormwater and Overflow:
1. Insulation Material: Mineral fiber
2. Insulation Thickness: 1 inch thick minimum.
3. Factory-Applied Jacket: ASJ-SSL.
4. Field-Applied Jacket: PVC on exposed piping in mechanical rooms or within 10' of floor in occupied spaces.
5. Vapor Barrier Required: Yes.

**END OF SECTION**

## SECTION 22 11 16 - 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. Aboveground domestic water pipes, tubes, and fittings inside buildings.

1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

1.4 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than 14 days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

## 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.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

F. Appurtenances for Grooved-End Copper Tubing:

1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 copper tube or ASTM B 584 bronze castings.
2. Mechanical Couplings for Grooved-End Copper Tubing:

    a) Copper-tube dimensions and design similar to AWWA C606.
    b) Ferrous housing sections.
    c) EPDM-rubber gaskets suitable for hot and cold water.
    d) Bolts and nuts.
    e) Minimum Pressure Rating: 300 psig.

2.3 STAINLESS-STEEL PIPING

A. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 10.

B. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.

C. Appurtenances for Grooved-End, Stainless-Steel Pipe:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a) Anvil International.
    b) Shurjoint Piping Products.
    c) Victaulic Company.

2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:

    a) AWWA C606 for stainless-steel-pipe dimensions.
    b) Stainless-steel housing sections.
    c) Stainless-steel bolts and nuts.
    d) EPDM-rubber gaskets suitable for hot and cold water.
    e) Minimum Pressure Rating:

        1) NPS 8 and Smaller: 600 psig.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

## 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 copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve, hose-end drain valve inside the building at each domestic water-riser. Comply with requirements for drain valves in Division 22 Section "Domestic Water Piping Specialties."

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install domestic water piping level without pitch and plumb.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. 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.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

## 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. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

G. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

J. Install transition couplings at joints of dissimilar piping.

K. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

## 3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

a) 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b) Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

c) Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
2. NPS 6: 12 feet with 3/4-inch rod.
3. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

G. Install supports for vertical stainless-steel piping every 15 feet.

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

## 3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

## 3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

## 3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

    a) Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b) 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:

        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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

    c) Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    d) Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

    a) Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    b) 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.
    c) 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.
    d) Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    e) Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
    f) Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a) Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b) Adjust calibrated balancing valves to flows indicated.

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

## 3.8 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 of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

   c) Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d) Repeat procedures if biological examination shows contamination.
   e) Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

## 3.9 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping:

1. NPS 3 and smaller: Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. NPS 4, shall be one of the following:

a) Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
b) Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
c) Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

3.10 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 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

**END OF SECTION**

## SECTION 22 11 19 - 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. Section Includes:
   1. Balancing valves.
   2. Drain valves.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a) Armstrong International, Inc.
      b) ITT Corporation; Bell & Gossett Div.
      c) NIBCO Inc.
      d) TACO Incorporated.

e) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
3. Body: Bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

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 minimum CWP.
3. Size: NPS 3/4.
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.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Install balancing valves in locations where they can easily be adjusted.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 LABELING AND IDENTIFYING

A. Install engraved valve tag for each of the following:
1. Calibrated balancing valves.

3.4 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

**END OF SECTION 221119**

## SECTION 22 13 16 - SANITARY WASTE AND 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. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water .

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than 14 days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

## 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 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings: ASTM C 1277 and ASTM C 1540; stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop

**PART 3 - EXECUTION**

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. 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 two 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.

K. 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.
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

M. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

## 3.2 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket or calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression and lead-and-oakum calked joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

## 3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:

   a) 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b) Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c) Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.5 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.6 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. Reinspection: 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. 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. 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.

3.7 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.8 PIPING SCHEDULE

A. Aboveground, Soil, Waste and Vent Piping: Use any of the following piping materials for each size range:

1. NPS 4 and smaller:

a) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
b) Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

**END OF SECTION**

# SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 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. Sleeves.
5. Escutcheons.
6. Grout.
7. Mechanical demolition.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Supports and anchorages.

### 1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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 duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical 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.

1.5 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.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 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 23 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 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 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.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

## 2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:
    a) Central Plastics Company.
    b) Eclipse, Inc.
    c) Watts Industries, Inc.; Water Products Div.
    d) Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:
    a) Central Plastics Company.
    b) Epco Sales, Inc.
    c) Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a) Advance Products & Systems, Inc.
b) Calpico, Inc.
c) Central Plastics Company.
d) Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a) Calpico, Inc.
b) Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a) Perfection Corp.
b) Precision Plumbing Products, Inc.
c) Sioux Chief Manufacturing Co., Inc.
d) Victaulic Co. of America.

## 2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

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

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

## 2.6 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.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION**

3.1 MECHANICAL DEMOLITION

A. Refer to Division 1 Sections "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

## 3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install 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) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c) Insulated Piping: One-piece, stamped-steel type with spring clips.
d) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
g) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
h) Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
i) Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
j) Bare Piping in Equipment Rooms: One-piece, cast-brass type.
k) Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
l) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a) Steel Pipe Sleeves: For pipes smaller than NPS 6.
b) Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

P. 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 7 Section "Fire Resistive Joint Systems" for materials.

Q. Verify final equipment locations for roughing-in.

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

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

## 3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

## 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are 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 mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

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

## 3.6 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section "Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

**END OF SECTION**

## SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC 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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

## PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

## 2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

**PART 3 - EXECUTION (NOT APPLICABLE)**

**END OF SECTION 230513**

## SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following general-duty valves:
   1. Copper-alloy ball valves.
   2. Ferrous-alloy butterfly valves.

B. Related Sections include the following:
   1. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and charts.
   2. Division 23 Section " Instrumentation and Control Devices for HVAC" for control valves and actuators.
   3. Division 23 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NBR: Acrylonitrile-butadiene rubber.
   4. PTFE: Polytetrafluoroethylene plastic.
   5. SWP: Steam working pressure.
   6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

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 B31.9 for building services piping valves.
   2. ASME B16.10 and ASME B16.34 for ferrous valve dimension and design criteria.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping and storage 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.
   4. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

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

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Extended Valve Stems: On insulated valves.

G. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

H. Threaded: With threads according to ASME B1.20.1.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:
   1. Milwaukee Valve Company.
   2. NIBCO INC.
   3. Watts Regulator Company.

B. Copper-Alloy Ball Valves, General: MSS SP-110, 600-psig minimum CWP rating bronze body with chrome-plated brass ball; reinforced PTFE or TFE seats; lever handle and blowout-proof stem.

C. Two-Piece, Copper-Alloy Ball Valves: Regular-port.

D. Three-Piece, Copper-Alloy Ball Valves: Full-port.

2.4 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:
   1. Milwaukee Valve Company.
   2. NIBCO INC.
   3. Watts Regulator Company.

B. Ferrous-Alloy Butterfly Valves: MSS SP-67, 200-psig CWP Rating, rated for dead end service to 150-psig, bubble-tight shutoff.
   1. Disc: Aluminum bronze ASTM B148
   2. Lining: EPDM lining
   3. Stem: Stainless steel stem with upper and lower alignment bearings
   4. Handle: 10-position lever handle with spring-loaded lock for valves NPS 2-1/2NPS 6.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Heating-Water Piping:
   1. Shutoff Service:
      a) NPS 2 and Smaller: Ball valves.
      b) NPS 2-1/2 and Larger: Butterfly valves.

2. Throttling Service:
   a) NPS 2 and Smaller: Ball valves.
   b) NPS 2-1/2 and Larger: Butterfly valves.

B. Select valves, except wafer and flangeless types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
   3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded]ends.
   5. For Grooved-End, Copper Tubing and Steel Piping: Valve ends may be grooved. Do not use for steam or steam condensate piping.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

3.4 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.

3.5 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.

**END OF SECTION**

## SECTION 23 05 29 - MECHANICAL HANGERS AND SUPPORTS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for mechanical system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment supports.

B. Related Sections include the following:

1. Division 5 Section for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 13 Section "Fire-Suppression Piping" for pipe hangers for fire-protection piping.
3. Division 22 Section "Mechanical Vibration" for vibration isolation devices.
4. Division 22 Section(s) "Metal Ducts" for duct hangers and 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 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

**PART 2 - PRODUCTS**

2.1 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 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. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Grinnell Corp.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. 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. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

## 2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a) B-Line Systems, Inc.; a division of Cooper Industries.
b) Empire Industries, Inc.
c) Hilti, Inc.
d) ITW Ramset/Red Head.
e) MKT Fastening, LLC.
f) Powers Fasteners.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

**PART 3 - EXECUTION**

3.1 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 on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a) Light (MSS Type 31): 750 lb.
    b) Medium (MSS Type 32): 1500 lb.
    c) Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a) Horizontal (MSS Type 54): Mounted horizontally.
    b) Vertical (MSS Type 55): Mounted vertically.
    c) Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

## 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.

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. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

M. 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) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c) Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. 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 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a) NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b) NPS 4: 12 inches long and 0.06 inch thick.

5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

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

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 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.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION**

## SECTION 23 05 48 - VIBRATION CONTROLS FOR HVAC 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Elastomeric isolation pads.
2. Spring hangers.
3. Pipe riser resilient supports.
4. Resilient pipe guides.

1.3 SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

1.5 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 VIBRATION ISOLATORS

A. Available Manufacturers:

B. Manufacturers:

1. Ace Mounting Co., Inc.
2. Amber/Booth Company, Inc.
3. B-Line Systems, Inc.
4. Isolation Technology, Inc.

5. Kinetics Noise Control, Inc.
6. Mason Industries, Inc.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation Co., Inc.
9. Vibration Mountings & Controls/Korfund.

C. Elastomeric Isolator Pads : Oil- and water-resistant natural rubber, arranged in multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Natural rubber.
2. Number of Layers: 2

D. Spring Hangers : Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

E. Pipe Riser Resilient Support : All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

F. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch- thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.3 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

### 3.2 INSTALLATION

A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 7 Section "Roof Accessories."

B. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

C. Install resilient bolt isolation washers on equipment anchor bolts.

### 3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
   1. Isolator deflection.

### 3.4 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Adjust active height of spring isolators.

C. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

### 3.5 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

### 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section.

**END OF SECTION**

## SECTION 23 05 53 - IDENTIFICATION FOR HVAC 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment markers.
   2. Access panel and door markers.
   3. Pipe markers.
   4. Duct markers.
   5. Stencils.
   6. Valve tags.
   7. Valve schedules.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Valve numbering scheme.

C. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Coordinate terminology with owner's naming/numbering convention.
2. Data:

   a) Name and number.

3. Size: 4-1/2 by 6 inches for equipment.

B. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.

1. Stencil Material: Metal or fiberboard.
2. Stencil Paint: Exterior, gloss, acrylic enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1, unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by owner. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.

2.6 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size 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-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

**PART 3 - EXECUTION**

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units and identify units.
3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:

a) Fans, blowers, primary balancing dampers, fire and fire/smoke dampers and VAV boxes.
b) Mark ceiling tile grids or access panels with color specific decal to identify the location of items referneced above. Provide as-built drawings and tag list of equipment located above ceilings and behind walls for record documents. Coordinate color/naming convention for tags with Engineer and Owner as part of submittal review process.

B. Stenciled Equipment Marker Option: Stenciled markers may be provided instead of laminated-plastic equipment markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

## 3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
   2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Stenciled Pipe Marker Option: Stenciled markers may be provided instead of manufactured pipe markers, at Installer's option. Install stenciled pipe markers with painted, color-coded bands or rectangles complying with ASME A13.1 on each piping system.
   1. Identification Paint: Use for contrasting background.
   2. Stencil Paint: Use for pipe marking.

C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed 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 nonaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

## 3.4 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:
   1. Green: For supply ducts.
   2. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
   3. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Stenciled Duct Marker Option: Stenciled markers, showing service and direction of flow, may be provided instead of laminated-plastic duct markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:
   a) Hot Water: 1-1/2 inches round.

2. Valve-Tag Color:
   a) Hot Water: Natural.
   b)

3. Letter Color:
   a) Hot Water: Black

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

**END OF SECTION**

## SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:

a) Constant-volume air systems.
b) Dual-duct systems (existing within scope limitations).
c) Variable-air-volume systems.

2. Hydronic Piping Systems:

a) Constant-flow systems.
b) Variable-flow systems.

3. Stair-tower pressurization testing and adjusting.
4. Verifying that automatic control devices are functioning properly.
5. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Balancing Devices: All installed devices necessary to achieve proper balancing of the system such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers.

D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

F. NC: Noise criteria.

G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

H. RC: Room criteria.

I. Report Forms: Test data sheets for recording test data in logical order.

J. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

K. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

L. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.

M. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

N. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

O. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

P. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

Q. TAB: Testing, adjusting, and balancing.

R. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

S. Test: A procedure to determine quantitative performance of systems or equipment.

T. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days from Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 90 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a) Submittal distribution requirements.
b) The Contract Documents examination report.
c) TAB plan.
d) Work schedule and Project-site access requirements.
e) Coordination and cooperation of trades and subcontractors.
f) Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." OR NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.

B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

**PART 2 - PRODUCTS (NOT APPLICABLE)**

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Verify that balancing devices are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
2. The TAB Firm shall review the Contract Documents and the Mechanical Contractor’s shop drawings to identify any additional balancing devices that are necessary to achieve a balanced system but not shown on the drawings. Furnish and install those additional balancing devices necessary to achieve a balanced system. Coordinate with the Mechanical Contractor to properly schedule this work. Failure to coordinate installation of these devices with the Mechanical Contractor will result in absorbing all costs associated with work of other trades that is affected by modification of building components and systems. All balancing devices and installations shall comply with other Division 15 sections.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fans. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine equipment for installation and for properly operating safety interlocks and controls.

N. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

## 3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

## 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

## 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of fan components.

L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
b) Measure static pressure directly at the fan outlet or through the flexible connection.
c) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

2. Measure static pressure across each component that makes up an blower coil unit, and other air-handling and -treating equipment.

a) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
2.

3.6 PROCEDURES FOR DUAL-DUCT SYSTEMS IN WORK SCOPE AREAS

A. Verify that the cooling coil is capable of full-system airflow, and set mixing boxes at full-cold airflow position for fan volume.

B. Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate mixing-box controls and to overcome resistance in the ducts and outlets downstream from mixing box.

1. If insufficient static pressure exists, increase the airflow at the fan.

C. Test and adjust the constant-volume mixing boxes as follows:

1. Verify both hot and cold operations by adjusting the thermostat and observing the air temperature and volume changes.
2. Verify sufficient inlet static pressure before making volume adjustments.
3. Adjust mixing box to indicated airflows within specified tolerances. Measure the airflow by Pitot-tube traverse readings, totaling the airflow of the outlets; or by measuring static pressure at mixing-box taps if provided by box manufacturer.

D. Remeasure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate mixing-box controls and to overcome resistance in the ducts and outlets downstream from mixing box.

E. Adjust variable-air-volume, dual-duct systems in the same way as constant-volume dual-duct systems, and adjust each mixing-box maximum- and minimum-airflow settings.

## 3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS (NEW VAV)

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

a) If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

## 3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

## 3.9 PROCEDURES FOR HYDRONIC SYSTEMS

A. Set calibrated balancing valves, if installed, at calculated presettings.

B. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

C. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

D. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

## 3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

## 3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

## 3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

## 3.13 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

## 3.14 PROCEDURES FOR STAIR-TOWER PRESSURIZATION SYSTEM MEASUREMENTS AND ADJUSTMENTS

A. Before testing, observe the stair tower to verify that construction is complete. Verify the following:

1. Walls and ceiling are free of unintended openings and are capable of achieving a pressure boundary.
2. Firestopping and sealants are installed.
3. Doors, door closers, and door gaskets are installed and adjusted.
4. If applicable, window installation is complete.

B. Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.

C. Test each stair tower as a single system. If multiple fans serve a single stair tower, operate the fans together.

D. Air Balance:

1. Open the doors indicated to be open and measure, adjust, and record the airflow of each:

   a) Stair-tower fan.
   b) Air outlet supplying the stair tower.

2. For ducted systems, measure the fan airflow by duct Pitot-tube traverse.

E. Pressurization Test:

1. After air balancing is complete, perform stair-tower pressurization tests.
2. Establish a consistent procedure for recording data throughout the entire test. Set the stair-tower side of the doors as the reference point and the floor side of the doors with positive pressure when higher than the stair tower, and negative pressure when lower than the stair tower.
3. With the HVAC systems operating in their normal mode of operation and the stair-tower pressurization systems off, measure and record the following:

   a) Pressure difference across each stair-tower door with all doors in the stairwell closed.
   b) Force necessary to open each door, using a spring-type scale.

4. With the HVAC systems operating and the stair-tower pressurization system activated, perform the following:

   a) Place building HVAC systems in their normal operating mode including equipment not used to implement smoke control, such as air-handling units, toilet exhaust fans, fan coil units, and similar equipment.
   b) Measure and record the pressure difference across each stair-tower door with all doors in the stair tower closed. Adjust the stair-tower pressure relief to prevent overpressurization.
   c) Use a spring scale to measure and record the force needed to open the door closest to the fan. With the initial door held in the open position, measure and record the pressure difference across each remaining closed stair-tower door.
   d) Open additional doors (up to the number indicated) one at a time, and measure and record the pressure difference across each remaining closed stair-tower door after the opening of each additional door.
   e) Open the doors indicated to be open and measure and record the direction and velocity through each of the open doors by a traverse of every 1 sq. ft. grid of door opening.

f) Calculate the average of the door velocity measurements. Compare the average velocity to the Contract Documents and governing code requirements.

5. Repeat the pressurization tests with the smoke-control systems and the HVAC systems operating.
6. Criteria for Acceptance:

a) The opening force on any door shall not exceed 30 lbf.
b) Code requirements.

F. Operational Tests:

1. Check the proper activation of the stair-tower pressurization system(s) in response to all means of activation, both automatic and manual.
2. Verify that each initiating occurrence produces the proper system response under each of the following modes of operation:

a) Normal.
b) Alarm.
c) Manual override of normal mode and alarm.
d) Return to normal.

3. Verify that the smoke detector at the stair pressurization fan inlet de-energizes the fan and closes the damper at the fan.
4. If standby power is provided for stair pressurization systems, test to verify that the stair pressurization systems operate while on both normal and standby power.
5. Conduct additional tests required by authorities having jurisdiction.

G. Prepare a complete report of observations, measurements, and deficiencies.

3.15 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.16 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.17 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.

7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a) Indicated versus final performance.
    b) Notable characteristics of systems.
    c) Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a) Settings for outside-, return-, and exhaust-air dampers.
    b) Conditions of filters.
    c) Cooling coil, wet- and dry-bulb conditions.
    d) Fan drive settings including settings and percentage of maximum pitch diameter.
    e) Inlet vane settings for variable-air-volume systems.
    f) Settings for supply-air, static-pressure controller.
    g) Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Fan coil Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

    a) Unit identification.
    b) Location.
    c) Make and type.
    d) Model number and unit size.
    e) Manufacturer's serial number.
    f) Unit arrangement and class.
    g) Discharge arrangement.
    h) Number of filters, type, and size.

2. Motor Data:

a) Make and frame type and size.
b) Horsepower and rpm.
c) Volts, phase, and hertz.
d) Full-load amperage and service factor.
e) Sheave make, size in inches, and bore.
f) Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a) Total airflow rate in cfm.
b) Total system static pressure in inches wg.
c) Fan rpm.
d) Discharge static pressure in inches wg.
e) Filter static-pressure differential in inches wg.
f) Cooling coil static-pressure differential in inches wg.
g) Outside airflow in cfm.
h) Return airflow in cfm.
i) Outside-air damper position.
j) Return-air damper position.

G. Apparatus-Coil Test Reports:

1. Coil Data:

a) System identification.
b) Location.
c) Coil type.
d) Number of rows.
e) Fin spacing in fins per inch o.c.
f) Make and model number.
g) Face area in sq. ft..
h) Tube size in NPS.
i) Tube and fin materials.
j) Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a) Airflow rate in cfm.
b) Average face velocity in fpm.
c) Air pressure drop in inches wg.
d) Outside-air, wet- and dry-bulb temperatures in deg F.
e) Return-air, wet- and dry-bulb temperatures in deg F.
f) Entering-air, wet- and dry-bulb temperatures in deg F.
g) Leaving-air, wet- and dry-bulb temperatures in deg F.
h) Water flow rate in gpm.
i) Water pressure differential in feet of head or psig.
j) Entering-water temperature in deg F.
k) Leaving-water temperature in deg F.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a) System identification.

b) Location.
c) Make and type.
d) Model number and size.
e) Manufacturer's serial number.
f) Arrangement and class.
g) Sheave make, size in inches, and bore.
h) Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

a) Make and frame type and size.
b) Horsepower and rpm.
c) Volts, phase, and hertz.
d) Full-load amperage and service factor.
e) Sheave make, size in inches, and bore.
f) Sheave dimensions, center-to-center, and amount of adjustments in inches.
g) Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):

a) Total airflow rate in cfm.
b) Total system static pressure in inches wg.
c) Fan rpm.
d) Discharge static pressure in inches wg.
e) Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a) System and air-handling unit number.
b) Location and zone.
c) Traverse air temperature in deg F.
d) Duct static pressure in inches wg.
e) Duct size in inches.
f) Duct area in sq. ft..
g) Indicated airflow rate in cfm.
h) Indicated velocity in fpm.
i) Actual airflow rate in cfm.
j) Actual average velocity in fpm.
k) Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

a) System and air-handling unit identification.
b) Location and zone.
c) Test apparatus used.
d) Area served.
e) Air-terminal-device make.
f) Air-terminal-device number from system diagram.
g) Air-terminal-device type and model number.

h) Air-terminal-device size.
i) Air-terminal-device effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a) Airflow rate in cfm.
b) Air velocity in fpm.
c) Preliminary airflow rate as needed in cfm.
d) Preliminary velocity as needed in fpm.
e) Final airflow rate in cfm.
f) Final velocity in fpm.
g) Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a) System and air-handling unit identification.
b) Location and zone.
c) Room or riser served.
d) Coil make and size.
e) Flowmeter type.

2. Test Data (Indicated and Actual Values):

a) Airflow rate in cfm.
b) Entering-water temperature in deg F.
c) Leaving-water temperature in deg F.
d) Water pressure drop in feet of head or psig.
e) Entering-air temperature in deg F.
f) Leaving-air temperature in deg F.

## 3.19 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

a) Measure airflow of at least 10 percent of air outlets.
b) Measure water flow of at least 5 percent of terminals.
c) Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d) Measure sound levels at two locations.
e) Measure space pressure of at least 10 percent of locations.
f) Verify that balancing devices are marked with final balance position.
g) Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

**END OF SECTION 23 05 93**

## SECTION 23 07 13 - DUCT INSULATION

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes semirigid and flexible duct, plenum, and breeching insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Division 23 Section "HVAC Piping Insulation" for insulation for piping systems.
3. Division 23 Section "Metal Ducts" for duct liner.

1.3 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate clearance requirements with duct Installer for insulation application.

1.7 SCHEDULING

A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mineral-Fiber Insulation:

a) CertainTeed Manson.
b) Johns Manville
c) Knauf FiberGlass GmbH.
d) Owens-Corning Fiberglas Corp.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

2.3 FIELD-APPLIED JACKETS

A. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
2. PVC Jacket Color: White or gray.
3. PVC Jacket Color: Custom color selected by the Architect.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..

1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Galvanized Steel: 0.005 inch thick.
3. Aluminum: 0.007 inch thick.
4. Brass: 0.010 inch thick.
5. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

D. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.

1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.

2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

**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.

B. 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.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply multiple layers of insulation with longitudinal and end seams staggered.

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.

1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

Q. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.

1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

## 3.4 MINERAL-FIBER INSULATION APPLICATION

A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a) On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b) On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c) Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d) Do not overcompress insulation during installation.

4. Impale insulation over anchors and attach speed washers.
5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Space anchor pins as follows:

a) On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b) On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c) Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d) Do not overcompress insulation during installation.

4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and

inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

## 3.5 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

## 3.6 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

## 3.7 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

C. Insulate the following plenums and duct systems:

1. Indoor concealed supply- and outside-air ductwork.
2. Indoor exposed supply- and outside-air ductwork.

D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
5. Flexible connectors.
6. Vibration-control devices.
7. Testing agency labels and stamps.
8. Nameplates and data plates.
9. Access panels and doors in air-distribution systems.

3.8 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: Supply-air ducts, concealed.

1. Material: Mineral-fiber board or mineral-fiber blanket .
2. Thickness: 1-1/2 inches.
3. Number of Layers: One.
4. Field-Applied Jacket: Glass cloth .
5. Vapor Retarder Required: Yes.

B. Service: Round, supply-air ducts, exposed in unoccupied spaces.

1. Material: Mineral-fiber blanket .
2. Thickness: 1-1/2 inches.
3. Number of Layers: One.
4. Field-Applied Jacket: Glass cloth PVC (for ducts in mechanical rooms or spaces hat are below 10 feet above level)
5. Vapor Retarder Required: Yes.

C. Service: Outside-air ducts, exposed.

1. Material: Mineral-fiber board .
2. Thickness: 2 inches.
3. Number of Layers: One.
4. Field-Applied Jacket: Glass cloth PVC (for ducts below 10 feet above floor level).
5. Vapor Retarder Required: Yes.

**END OF SECTION**

## SECTION 23 07 19 - HVAC PIPING 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 insulating the following HVAC piping systems:
   1. Condensate drain piping.
   2. Steam Condensate piping.
   3. Heating hot-water and Cooling Chilled Water piping.

B. Related Sections:
   1. Division 23 Section "Duct Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. 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.

C. Field quality-control reports.

1.5 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to 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 agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Volatile Organic Compound Limits: Adhesives and sealants for interior use shall comply with South Coast Air Quality Management District (SCAQMD) Rule 1168.

D. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

   a) One 10-foot section of NPS 2 straight pipe.
   b) One each of a 90-degree threaded, welded, and flanged elbow.
   c) One each of a threaded, welded, and flanged tee fitting.
   d) One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
   e) Four support hangers including hanger shield and insert.
   f) One threaded reducer and one welded reducer.
   g) One pressure temperature tap.
   h) One mechanical coupling.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Owner seven days in advance of dates and times when mockups will be constructed.
4. Obtain Owner's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation; remove it from the project site.

## 1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application.

C. Coordinate installation and testing of heat tracing.

## 1.8 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 "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a) Johns Manville; Micro-Lok HP.
      b) Knauf Insulation; 1000-Degree Pipe Insulation with ECOSE Technology.
      c) Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850º F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 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.

A. Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. VOC limit for indoor applications: 80 g/L.

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. VOC limit for indoor applications: 50 g/L.

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. VOC limit for indoor applications: 50 g/L.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. VOC limit for indoor applications: 50 g/L.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180º F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180º F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

## 2.5 SEALANTS

A. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250º F.
4. Color: White.
5. VOC limit for indoor applications: 420 g/L.

## 2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

## 2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

## 2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 30 mils thick; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:
   1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
   2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
   3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems 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 according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets specified by the manufacturer.
   1. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation on vibration-control devices.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations: Install insulation continuously through walls and partitions.
   1. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Insulation Installation at Floor Penetrations: Install insulation continuously through floor penetrations.
   1. 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, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate piping and fittings left exposed after hazardous materials abatement.
   3. 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.
   4. 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.
   5. 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.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FINISHES

A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a) Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. 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 each of the following for each pipe service:
   a) Straight pipe sections.
   b) Threaded fittings.
   c) Welded fittings.
   d) Threaded valves
   e) Flanged valves.

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

3.10 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.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. If more than one material is listed, selection from materials listed is Contractor's option.

B. Condensate and Equipment Drain Water below 60º F:
   1. Insulation Material: Mineral fiber or flexible elastomeric.
   2. Insulation Thickness: 1 inch thick minimum.
   3. Factory-Applied Jacket: ASJ-SSL.
   4. Field-Applied Jacket: PVC on exposed piping in mechanical rooms or within 10’ of floor in occupied spaces.
   5. Vapor Barrier Required: Yes.

C. Steam Condensate:
   1. Insulation Material: Mineral fiber
   2. Insulation Thickness:
      a) NPS 1-1/2 and Smaller: 1-1/2 inch thick minimum.
      b) NPS 2 and Larger: 2 inch thick minimum.
   3. Factory-Applied Jacket: ASJ-SSL.
   4. Field-Applied Jacket: PVC on exposed piping in mechanical rooms or within 10’ of floor in occupied spaces.
   5. Vapor Barrier Required: No.

D. Heating-Hot-Water Supply and Return, 200º F and Below and Cooling Chilled Water above 40º F :
   1. Insulation Material: Mineral fiber
   2. Insulation Thickness:
      a) NPS 1-1/2 and Smaller: 1-1/2 inch thick minimum.
      b) NPS 2 and Larger: 2 inch thick minimum.
   3. Factory-Applied Jacket: ASJ-SSL.
   4. Field-Applied Jacket: PVC on exposed piping in mechanical rooms or within 10’ of floor in occupied spaces.
   5. Vapor Barrier Required for heating hot water: No.

6. Vapor Barrier Required for cooling chilled water: Yes.

**END OF SECTION**

**SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC**

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 control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
    b. Water Flow: Plus or minus 5 percent of full scale.
    c. Water Pressure: Plus or minus 2 percent of full scale.
    d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
    e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
    f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
    g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
    h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
    i. Relative Humidity: Plus or minus 5 percent.
    j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
    k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
    l. Airflow (Terminal): Plus or minus 10 percent of full scale.
    m. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
    n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
    o. Carbon Monoxide: Plus or minus 5 percent of reading.
    p. Carbon Dioxide: Plus or minus 50 ppm.
    q. Electrical: Plus or minus 5 percent of reading.

## 1.5 SEQUENCE OF OPERATION

A. See drawings for sequence of operations.

## 1.6 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

    1. DDC System Hardware: Connect to existing Trane Tracer system.
    2. Control System Software: Connect to existing Trane Tracer system.
    3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

    1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between existing operator workstation and new control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

## 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

1.10 COORDINATION

A. Coordinate location of thermostats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Section 283111 "Fire-Alarm System" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate supply of conditioned electrical branch circuits for control units.

D. Coordinate equipment with Section 260913 "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

E. Coordinate equipment with Section 262416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.

F. Coordinate equipment with to achieve compatibility with motor starters and annunciation devices.

**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 CONTROL SYSTEM

A. Manufacturers:
   1. Trane; Worldwide Applied Systems Group

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems. All components shall be compatible with the existing Trane Tracer control system.

2.3 DDC EQUIPMENT

a. Operator Workstation: Existing to remain.

2. Application Software: Existing to remain.

B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
d. Remote communications.
e. Maintenance management.
f. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

## 2.4 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
3. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).

## 2.5 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.

1. Alarm Condition: Indicating light flashes and horn sounds.
2. Acknowledge Switch: Horn is silent and indicating light is steady.
3. Second Alarm: Horn sounds and indicating light is steady.
4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
5. Contacts in alarm panel allow remote monitoring by independent alarm company.

## 2.6 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

C. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

## 2.7 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:
   a. Trane

2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.

   a. Set-Point Adjustment: Concealed.
   b. Set-Point Indication: Concealed.
   c. Thermometer: Concealed.
   d. Color: White or off-white.

C. RTDs and Transmitters:

1. Manufacturers:
   a. Trane

2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.

   a. Set-Point Adjustment: Concealed.
   b. Set-Point Indication: Concealed.
   c. Thermometer: Concealed.
   d. Color: White or off-white.

D. Pressure Transmitters/Transducers:

1. Manufacturers:
   a. Trane

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
   d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).
3. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

## 2.8 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

B. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

C. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

## 2.9 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

   a. Belimo Aircontrols (USA), Inc.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
   e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
12. Run Time: 30 seconds.

## 2.10 CONTROL VALVES

A. Manufacturers:

1. Danfoss Inc.; Air Conditioning & Refrigeration Div.
2. Erie Controls.
3. Hayward Industrial Products, Inc.
4. Magnatrol Valve Corporation.
5. Neles-Jamesbury.
6. Parker Hannifin Corporation; Skinner Valve Division.
7. Pneuline Controls.
8. Sauter Controls Corporation.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate or the following:

    a. Two Position: Line size.
    b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

## 2.11 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).

1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

2.12 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Section 271500 "Communications Horizontal Cabling."

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that power supply is available to control units.

3.2 INSTALLATION

A. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install automatic dampers according to Section 233300 "Air Duct Accessories."

E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

F. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

G. Install hydronic instrument wells, valves, and other accessories according to Section 232113 "Hydronic Piping."

H. Install duct volume-control dampers according to Section 233113 "Metal Ducts".

I. Install electronic and fiber-optic cables according to Section 271500 "Communications Horizontal Cabling."

## 3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Section 271500 "Communications Horizontal Cabling."
   1. Install exposed cable in raceway.
   2. Install concealed cable in raceway.
   3. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   4. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

## 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   4. Test each point through its full operating range to verify that safety and operating control set points are as required.
   5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   6. Test each system for compliance with sequence of operation.
   7. Test software and hardware interlocks.

C. DDC Verification:

   1. Verify that instruments are installed before calibration, testing, and loop checks.

2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check temperature instruments and material and length of sensing elements.
6. Check control valves. Verify that they are in correct direction.
7. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

## 3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

6. Temperature:

    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

7. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
8. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
9. Provide diagnostic and test instruments for calibration and adjustment of system.
10. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

## 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training."

**END OF SECTION 23 09 00**

## SECTION 23 21 13 - HYDRONIC 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 pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condensate-drain piping.
4. Steam Condensate Piping

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Chemical and Glycol treatment.
4. Hydronic specialties.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

1.7 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

## PART 2 - PRODUCTS

### 2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Anvil International, Inc.
b) S. P. Fittings; a division of Star Pipe Products.
c) Victaulic Company.

2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

C. Wrought-Copper Unions: ASME B16.22.

### 2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a) Anvil International, Inc.
   b) Central Sprinkler Company; a division of Tyco Fire & Building Products.
   c) S. P. Fittings; a division of Star Pipe Products.
   d) Victaulic Company.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

## 2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

   a) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

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) Capitol Manufacturing Company.
   b) Central Plastics Company.
   c) Hart Industries International, Inc.
   d) Jomar International Ltd.
   e) Matco-Norca, Inc.
   f) McDonald, A. Y. Mfg. Co.
   g) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h) Wilkins; a Zurn company.

2. Description:

   a) Standard: ASSE 1079.
   b) Pressure Rating: 125 psig minimum at 180 deg F.
   c) End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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) Capitol Manufacturing Company.
   b) Central Plastics Company.
   c) Matco-Norca, Inc.
   d) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e) Wilkins; a Zurn company.

2. Description:

   a) Standard: ASSE 1079.
   b) Factory-fabricated, bolted, companion-flange assembly.
   c) Pressure Rating: 125 psig minimum at 180 deg F.
   d) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

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) Advance Products & Systems, Inc.
   b) Calpico, Inc.

c) Central Plastics Company.
d) Pipeline Seal and Insulator, Inc.

2. Description:

a) Nonconducting materials for field assembly of companion flanges.
b) Pressure Rating: 150 psig .
c) Gasket: Neoprene or phenolic.
d) Bolt Sleeves: Phenolic or polyethylene.
e) Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

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) Elster Perfection.
b) Grinnell Mechanical Products.
c) Matco-Norca, Inc.
d) Precision Plumbing Products, Inc.
e) Victaulic Company.

2. Description:

a) Standard: IAPMO PS 66
b) Electroplated steel nipple. complying with ASTM F 1545.
c) Pressure Rating: 300 psig at 225 deg F .
d) End Connections: Male threaded or grooved.
e) Lining: Inert and noncorrosive, propylene.

2.5 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Armstrong Pumps, Inc.
b) Bell & Gossett Domestic Pump; a division of ITT Industries.
c) Flow Design Inc.
d) Gerand Engineering Co.
e) Griswold Controls.
f) Taco.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.

7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

C. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a) Armstrong Pumps, Inc.
   b) Bell & Gossett Domestic Pump; a division of ITT Industries.
   c) Flow Design Inc.
   d) Gerand Engineering Co.
   e) Griswold Controls.
   f) Taco.
   g) Tour & Andersson; available through Victaulic Company.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

## 2.6 AIR CONTROL DEVICES

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

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

2.7 CHEMICAL TREATMENT

1. Coordinate chemicals and glycol to match existing chemicals used. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
2. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

**PART 3 - EXECUTION**

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, shall be either of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Chilled-water piping, aboveground, shall be either of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

C. Steam Condensate piping, aboveground, shall be of the following:

1. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

## 3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping**,** NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

T. Install sleeves for piping penetrations of walls, ceilings, and floors.

U. Install sleeve seals for piping penetrations of concrete walls and slabs.

V. Install escutcheons for piping penetrations of walls, ceilings, and floors.

## 3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

## 3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. 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.

F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

## 3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

## 3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections.

## 3.8 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

1. pH: 9.0 to 10.5.
2. "P" Alkalinity: 100 to 500 ppm.
3. Boron: 100 to 200 ppm.
4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
5. Corrosion Inhibitor:

a) Sodium Nitrate: 1000 to 1500 ppm.
b) Molybdate: 200 to 300 ppm.
c) Chromate: 200 to 300 ppm.
d) Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
e) Chromate Plus Molybdate: 50 to 100 ppm each.

6. Soluble Copper: Maximum 0.20 ppm.
7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
8. Total Suspended Solids: Maximum 10 ppm.
9. Ammonia: Maximum 20 ppm.
10. Free Caustic Alkalinity: Maximum 20 ppm.
11. Microbiological Limits:

a) Total Aerobic Plate Count: Maximum 1000 organisms/ml.
b) Total Anaerobic Plate Count: Maximum 100 organisms/ml.
c) Nitrate Reducers: 100 organisms/ml.
d) Sulfate Reducers: Maximum 0 organisms/ml.
e) Iron Bacteria: Maximum 0 organisms/ml.

B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

C. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

D. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
1. Verify percentage and type of glycol with owner prior to submittals.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
4. Set temperature controls so all coils are calling for full flow.
5. Verify lubrication of motors and bearings.

**END OF SECTION**

## SECTION 23 31 13 - METAL DUCTS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:

1. Rectangular ducts and fittings.
2. Single-wall, round**,** and flat-oval spiral-seam ducts and formed fittings.
3. Double-wall, round**,** and flat-oval spiral-seam ducts and formed fittings.

B. Related Sections include the following:
1. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
2. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according toAWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

## PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.

C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.3 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2.4 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:

a) Ductmate Industries, Inc.
b) Nexus Inc.
c) Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Manufacturers:

a) Ductmate Industries, Inc.
b) Lockformer.

2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.5 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Flat-Oval, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."Fabricate ducts larger than 72 inches in diameter with butt-welded longitudinal seams.

1. Manufacturers:

a) McGill AirFlow Corporation.
b) SEMCO Incorporated.

D. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

   a) Manufacturers:

      1) Ductmate Industries, Inc.
      2) Lindab Inc.

5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

   a) Manufacturers:

      1) Ductmate Industries, Inc.
      2) McGill AirFlow Corporation.
      3) SEMCO Incorporated.

E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:

   a) Ducts 3 to 36 Inches in Diameter: 0.034 inch.
   b) Ducts 37 to 50 Inches in Diameter: 0.040 inch.
   c) Ducts 52 to 60 Inches in Diameter: 0.052 inch.
   d) Ducts 62 to 84 Inches in Diameter: 0.064 inch.

3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:

   a) Ducts 3 to 26 Inches in Diameter: 0.034 inch.

b) Ducts 27 to 50 Inches in Diameter: 0.040 inch.
c) Ducts 52 to 60 Inches in Diameter: 0.052 inch.
d) Ducts 62 to 84 Inches in Diameter: 0.064 inch.

4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
6. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
8. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
12. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

## 2.6 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Manufacturers:

1. Lindab Inc.
2. McGill AirFlow Corporation.
3. SEMCO Incorporated.

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 3-inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.

   a) Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:

   a) Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
   b) Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.

c) Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
d) Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.

4. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid Inner Ducts: Use the following sheet metal thicknesses:

a) Ducts 3 to 34 Inches in Diameter: 0.028 inch.
b) Ducts 35 to 58 Inches in Diameter: 0.034 inch.
c) Ducts 60 to 88 Inches in Diameter: 0.040 inch.

## PART 3 - EXECUTION

### 3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Main Ducts: 4-inch wg.
2. Supply Ducts (before Air Terminal Units): 2-inch wg.
3. Supply Ducts (after Air Terminal Units): 1-inch wg.
4. Supply Ducts (in Mechanical Equipment Rooms): 4-inch wg.
5. Return Ducts (Negative Pressure): 1-inch wg.
6. Exhaust Ducts (Negative Pressure): 1-inch wg.

B. All ducts shall be galvanized steel except as follows:

### 3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round and flat-oval ducts in lengths not less than 5 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."

O. Protect duct interiors from the elements and foreign materials until building is enclosed.

P. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

## 3.3 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg, seal transverse joints.

B. Seal ducts before external insulation is applied.

## 3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

## 3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.6 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

## 3.7 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Coils and related components.
4. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
5. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and reinspect ducts.

3.8 CLEANING EXISTING SYSTEMS (DUCTS TO REMAIN WITHIN WORK ZONES)

A. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Use existing service openings where possible.
2. Create other openings to comply with duct standards.
3. Disconnect flexible ducts as needed for cleaning and inspection.
4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
5. Remove and reinstall ceiling sections to gain access during the cleaning process.

B. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
3. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and reinspect ducts.

**END OF SECTION 23 31 13**

**SECTION 23 31 19 - HVAC CASINGS**

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. Shop-fabricated, field-assembled, double-wall casings for HVAC equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Static-Pressure Classes:
1. Downstream from Fan(s): 10-inch wg (2500 Pa).

B. Acoustical Performance:

1. NRC: 1.09 according to ASTM C 423.
2. STC: 40 according to ASTM E 90.

C. Structural Performance:

1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot (0.97 mm per meter) of width.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.

1. Detail HVAC casing assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Sheet metal thickness(es).
3. Reinforcement and spacing.
4. Seam and joint construction.

5. Access doors including frames, hinges, and latches.
6. Locations for access to internal components.
7. Hangers and supports including methods for building attachment, vibration isolation, and casing attachment.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For acoustically critical casings, from manufacturer.

1. Show sound-absorption coefficients in each octave band when tested according to ASTM C 423.
2. Show airborne sound transmission losses when tested according to ASTM E 90.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for casing joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.7 COORDINATION

A. Coordinate sizes and locations of steel supports.

**PART 2 - PRODUCTS**

2.1 GENERAL CASING FABRICATION REQUIREMENTS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 9, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
1. Casings with more than 2-inch wg (500-Pa) positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Exterior Surface Galvanized Coating Designation: **G90 (Z275)**.
2. Interior Surface Galvanized Coating Designation:

    a. Sections Not Exposed to Moisture: **G90 (Z275)**.
    b. Sections Housing and Downstream from Cooling Coil and Humidifiers: **G90 (Z275)**.

C. Shop-Applied Antimicrobial Coating:

1. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.
5. Applied Coating Color: Standard.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.

F. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation.

G. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 9-15, "Casing Access Doors - 2-inch wg (500 Pa)," and Figure 9-16, "Casing Access Doors - 3-10-inch wg (750-2500 Pa)"; and according to pressure class of the plenum or casing section in which access doors are to be installed.

1. Size: 20 by 54 inches (500 by 1370 mm).
2. Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
3. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
5. Neoprene gaskets around entire perimeters of door frames.
6. Doors shall open against air pressure.

## 2.2 SHOP-FABRICATED CASINGS

A. Double-Wall Casings: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

B. Double-Wall Casing Inner Panel: Solid sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

C. Interstitial Insulation: Polyurethane foam complying with NFPA 90A or NFPA 90B.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
2. Coat insulation with antimicrobial coating.
3. Cover insulation with polyester film complying with UL 181, Class 1.

E. Fabricate casings with standing seams and angle-iron reinforcements unless otherwise indicated.

F. Fabricate close-off sheets from casing to dampers, filter frames, and coils and between stacked coils. Use galvanized sheet steel of same thickness as casing and with a galvanized coating designation of G90 (Z275).

G. Bolt close-off sheets to frame flanges and housings. Support coils on stands fabricated from galvanized-steel angles or channels.

H. Reinforce casings with galvanized-steel angles.

## 2.3 SEALANT MATERIALS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
9. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
10. Service: Indoor or outdoor.
11. Substrate: Compatible with galvanized sheet steel or stainless steel.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. VOC: Maximum 395 g/L.
9. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel or stainless steel.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single component, acid curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine steel supports for compliance with requirements for conditions affecting installation and performance of HVAC casings.

B. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.

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

### 3.2 INSTALLATION

A. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Apply sealant to joints, connections, and mountings.

C. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Support casings on floor or foundation system. Secure and seal to base.

E. Support components rigidly with ties, braces, brackets, and anchors of types that will maintain housing shape and prevent buckling.

F. Align casings accurately at connections, with 1/8-inch (3-mm) misalignment tolerance and with smooth interior surfaces.

## 3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."
2. Test the following systems:

   a. Systems required by ASHRAE/IESNA 90.1.
   b. Supply Air: 100 percent of total installed duct area with a pressure class of 4-inch wg (1000 Pa) or higher.

3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
4. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.
5. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

B. HVAC casings will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

## 3.4 CLEANING

A. Comply with requirements for cleaning in Section 233113 "Metal Ducts."

**END OF SECTION 233119**

## SECTION 23 33 00 - AIR DUCT ACCESSORIES

## 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. Manual volume dampers.
   2. Control dampers.
   3. Combination fire and smoke dampers.
   4. Flange connectors.
   5. Turning vanes.
   6. Duct-mounted access doors.
   7. Flexible connectors.
   8. Flexible ducts.
   9. Duct accessory hardware.

B. Related Requirements:
   1. Section 28 31 11 "Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. For control dampers, include leakage, pressure drop and maximum pressure data ratings..

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

## 2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a) Air Balance Inc.; a division of Mestek, Inc.
   b) Nailor Industries Inc.
   c) Ruskin Company.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

   a) Frame: Hat-shaped, 16 gauge thick, galvanized sheet steel.
   b) Mitered and welded corners.
   c) Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a) Multiple or single blade.
   b) Parallel- or opposed-blade design.
   c) Stiffen damper blades for stability.
   d) Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

   a) Oil-impregnated bronze or molded synthetic.
   b) Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

## 2.4 STEEL CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arrow United Industries; a division of Mestek, Inc.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
   1. Maximum Leakage: 3 cfm/sq ft at 1” static pressure.

C. Frames: 5” x 1” 16 ga. galvanized or type 304 stainless steel hat channel with gusseted corner braces.

D. Blades: 6-inch (150 mm) maximum width, galvanized or type 304 stainless steel airfoil shaped with double skin construction of 14 ga (2 mm) equivalent thickness, in Opposed-blade configuration.

E. Seals: Nonmetallic edge seals and flexible metal jamb seals.

F. Blade Axles: 1/2-inch- diameter; galvanized or type 304 stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

G. Bearings: Oil-impregnated bronze or stainless steel sleeve.
   1. Provide thrust bearings for dampers with blades to be mounted vertically.

H. Operating Temperature Range: -40ºF to 180ºF

## 2.5 COMBINATION FIRE AND SMOKE DAMPERS

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

   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   3. Greenheck Fan Corporation.
   4. Nailor Industries Inc.
   5. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with interlocking, gusseted or mechanically attached corners and mounting flange.

F. Heat-Responsive Device: Resettable 165ºF rated, fusible links.

G. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- thick, galvanized sheet steel.

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.039-inch thick, galvanized sheet steel; length to suit wall or floor application.

K. Damper Motors: Two-position action.

L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40ºF.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

M. Accessories:

1. Auxiliary switches for signaling, fan control and position indication.
2. Test and reset switches, remote mounted.

## 2.6 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.7 TURNING VANES

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

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

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Elgen Manufacturing.
5. Flexmaster U.S.A., Inc.
6. Greenheck Fan Corporation.
7. McGill AirFlow LLC.
8. Nailor Industries Inc.
9. KEES MFG..
10. Ventfabrics, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

   a) Double wall, rectangular.
   b) Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c) Vision panel.
   d) Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
   e) Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

   a) Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b) Access Doors up to 18 Inches] Square: Two hinges and two sash locks.
   c) Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
   d) Access Doors Larger Than 24 by 48 Inches: Four hinges] and two compression latches with outside and inside handles.

## 2.9 FLEXIBLE CONNECTORS

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

   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. Elgen Manufacturing.
   4. Ventfabrics, Inc.
   5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200ºF.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250ºF.

2.10 FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Noninsulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210ºF.

C. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160ºF.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1 .

D. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

**PART 3 - EXECUTION**

3.1 CONTROL DAMPER APPLICATIONS

A. If damper applications are not otherwise indicated, use the following:

| | |
|---|---|
| 1. Modulating or Throttling: | Opposed-blade. |
| 2. Two-position Shutoff: | Parallel- or opposed-blade. |
| 3. Outside Air: | Thermally broken dampers. |

3.2 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steels.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

   1. Install steel volume dampers in steel ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers according to UL listing.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. At outdoor-air intakes and mixed-air plenums.
   2. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   4. At each change in direction and at maximum 50-foot spacing.
   5. Upstream and downstream from turning vanes.
   6. Control devices requiring inspection.
   7. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:

   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
   3. Head and Hand Access: 18 by 10 inches.
   4. Head and Shoulders Access: 21 by 14 inches.
   5. Body Access: 25 by 14 inches.
   6. Body plus Ladder Access: 25 by 17 inches.

J. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with draw bands .

P. Install duct test holes where required for testing and balancing purposes.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

**END OF SECTION 233300**

## SECTION 23 34 23 - HVAC POWER VENTILATORS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Centrifugal roof ventilators.
   2. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on actual site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material gages and finishes.
   5. Dampers, including housings, linkages, and operators.

B. Coordination Drawings: Show roof penetration requirements drawn to scale and coordinating roof penetrations. Show the following:

   1. Roof framing and support members relative to duct penetrations.

C. Maintenance Data: For power ventilators to include in maintenance manuals specified in Division 1.

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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cook, Loren Company.
2. Greenheck Fan Corp.
3. Penn Ventilation Companies, Inc.
4. Trane Co. (The).
5. Twin City Fan & Blower

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

1. Housing: Louvered or solid panel baked enamel painted sheet metal casing.

B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

C. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

3. Pulleys: Cast-iron, adjustable-pitch motor pulley.

D. Accessories:

1. Variable Speed Drive.
2. Disconnect Switch.
3. Bird Screens at intakes: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Motorized Dampers..

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 16 inches.
3. Metal Liner: Galvanized steel.

2.3 PROPELLER FANS

A. Description: Direct-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

B. Housing: Galvanized steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Accessories:
1. Weathershield Hood: Galvanized steel to match fan and accessory size.
2. Weathershield Front Guard: Galvanized steel with expanded metal screen.
3. Variable-Speed Drive.
4. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.4 MOTORS

A. Comply with requirements in Division 23 Section "Motors."

B. Enclosure Type: Guarded dripproof.

2.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

**PART 3 - EXECUTION**

## 3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using spring isolators having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Mechanical Vibration Controls."

C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 Section "Roof Accessories" for installation of roof curbs.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

## 3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

## 3.3 FIELD QUALITY CONTROL

A. Equipment Startup Checks:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Verify lubrication for bearings and other moving parts.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
7. Disable automatic temperature-control operators.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.
2. Measure and record motor voltage and amperage.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Shut unit down and reconnect automatic temperature-control operators.

F. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

G. Replace fan and motor pulleys as required to achieve design airflow.

H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.5 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

**END OF SECTION**

**SECTION 23 36 00 - AIR TERMINAL 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. Single-duct air terminal units.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units.

1.5 QUALITY ASSURANCE

A. 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.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

**PART 2 - PRODUCTS**

2.1 SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Environmental Technologies, Inc.
2. Krueger.

3. Price Industries.
4. Titus.
5. Trane; a business of American Standard Companies.
6. Carrier Corporation

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch (0.85-mm) steel single wall.

1. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

   a. Cover liner with nonporous foil.
2. Air Inlet: Round stub connection for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to 140 deg F (minus 18 to plus 60 deg C), shall be impervious to moisture and fungus, shall be suitable for 10-inch wg (2500-Pa) static pressure, and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
2. Damper Position: Normally closed.

F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.

G. Electric Controls: Damper actuator.

1. Damper Actuator: 24 V, powered closed, powered open.

H. Control Sequence:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.
2. DDC System-powered, wall-mounted thermostat.

2.2 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type**,** and ARI certification seal.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted temperature sensors. Connect to existing DDC system.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

C. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Section 233113 "Metal Ducts."

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

## 3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform 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. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air terminal unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

**END OF SECTION 23 36 00**

## SECTION 23 37 13 - DIFFUSERS, REGISTERS AND GRILLES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

## PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS AND DIFFUSERS

A. Grilles, registers and diffusers shall be as manufactured by Titus, Carnes, Anemostat, MetalAire, Krueger, Price or Tuttle & Bailey.

B. Types, sizes, patterns, deflections, finishes, and all accessories are scheduled on the drawings.

C. All grilles registers and diffusers shall be compatible with adjacent wall and ceiling systems. Confirm ceiling type with existing conditions and architectural plans and provide appropriate frame.

D. Provide 3 operating keys for each type of volume damper.

E. Provide galvanized sheet metal transitions, collars, or plenums for attaching grilles to ductwork.

F. All grilles, registers, and diffusers located in suspended lay-in ceilings shall be with compatible with the following ceiling grid systems:
1. Standard width 15/16” ceiling tees.
2. Narrow width 9/16” ceiling tees.

## PART 3 - PART 3 EXECUTION

3.1 GRILLES, REGISTERS AND DIFFUSERS

A. Install ceiling grilles, diffusers and registers where shown on drawings.

B. Coordinate exact location of ceiling grilles, diffusers and registers with new and existing electrical lighting and architectural reflected ceiling plans and existing conditions.

C. Confirm proper orientation of all units with unit manufacturer.

**END OF SECTION**

## SECTION 23 82 19 - FAN COIL UNITS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fan-coil units and accessories.

1.3 SUBMITTALS

A. Product Data: Include specialties and accessories for each unit type and configuration.

B. Shop Drawings: Submit the following for each fan-coil unit type and configuration:

1. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
3. Power, signal, and control wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.
4. Equipment schedules to include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section.

D. Maintenance Data: For fan-coil units to include in maintenance manuals specified in Division 1. Include the following:

1. Maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

1.4 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.

1.5 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.6 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. Fan-Coil Unit Filters: Furnish two spare filters for each filter installed.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corp.
   2. International Environmental Corp.
   3. McQuay International.
   4. Trane Company (The); North American Commercial Group.

2.2 CONFIGURATION

A. Horizontal Units: An assembly including cabinet, filter, chassis, coil, drain pan, fan, and motor in blow-through configuration with hydronic cooling coil.

2.3 MATERIALS

A. Chassis: Galvanized steel, with flanged edges.

B. Coil Section Insulation: 1-inch duct liner complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

   1. Fire-Hazard Classification: Duct liner and adhesive shall have a maximum flame-spread rating of 25 and smoke-developed rating of 50 when tested according to ASTM E 84.

C. Drain Pans: Galvanized steel, with connection for drain. Drain pan shall be insulated with polystyrene or polyurethane insulation. Drain pan shall be formed to slope from all directions to drain connection.

D. Cabinet: Galvanized steel, with removable panels.
   1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain.

E. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on primer with manufacturer's standard paint, in color selected by Architect, applied to factory-assembled and -tested fan-coil unit before shipping.

2.4 WATER COILS

A. Primary Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and with manual air vent. Coils shall be rated for a minimum working pressure of 300 psig and a maximum entering water temperature of 275 deg F.

2.5 FAN

A. Centrifugal, with forward-curved, double-width wheels and fan scrolls made of galvanized steel or thermoplastic material; directly connected to or V-belt driven from motor.

2.6 FAN MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Motors for Direct-Drive Units: Multispeed motor with integral thermal-overload protection and resilient mounts.

C. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.7 ACCESSORIES

A. Filters: 1-inch- thick, throwaway filters in fiberboard frames.

2.8 CONTROL SYSTEMS

A. Two-Pipe, Fan Cycle: Wall-mounted sensor cycles fan from manually set speed to off.

B. Two-Pipe, Valve Cycle: Wall-mounted sensor, cycles normally closed electric valve.

2.9 SOURCE QUALITY CONTROL

A. Test and rate units according to ARI 440.

B. Test unit coils according to ASHRAE 33.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil unit installation.

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

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with vibration isolators. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Install wall-mounting DDC sensor controls in electrical outlet boxes at heights to match lighting controls.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.

C. Install piping adjacent to machine to allow service and maintenance.

D. Ground equipment.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and report results in writing:

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.

B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. After installing units, clean fan-coil units internally according to manufacturer's written instructions.

C. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals. Refer to Division 1.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

**END OF SECTION**

## SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 WORK INCLUDED IN THE ELECTRICAL CONTRACT

A. The mention of any Article, operation or method required that the Contractor shall provide same and perform each operation in complete accordance with the conditions stated. The Contractor shall provide all material, labor, equipment and transportation as necessary to complete the project in compliance with the Contract Documents. In general, this work includes everything essential for a complete electrical system in operating order as shown on the drawings and indicated in the specifications.

B. All work shall be installed in accordance with all State and Local Inspection Authorities having jurisdiction together with the recommendations of the manufacturer whose equipment is to be supplied and installed under this Contract.

C. Before submitting a bid, each bidder shall examine the drawings relating to their work and shall become fully informed as to the extent and character of the work required and its relation to other work in the building.

D. The Contractor, in conjunction with the Architect's representative, shall establish exact locations of all materials and equipment to be installed. Consideration shall be given to construction features, equipment of other trades and requirements of the equipment proper.

E. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for deliver, erection and installation of all equipment and apparatus required to be installed by the Contractor. All such equipment shall be removed by the Contractor upon completion of the project.

F. The Contractor shall provide all necessary temporary lighting, distribution and electrical service as required for project.

G. The Contractor shall be responsible for all work identified on the plans and in Divisions 26, 27 & 28 and include all costs in bid.

### 1.3 DEFINITIONS

A. The Owner: The individual who the Owner selects as the project representative.

B. The Architect: eppstein uhen: architects, Milwaukee, Wisconsin.

C. The Engineer: Powrtek Engineering, Inc., Consulting Engineers, Waukesha, Wisconsin.

D. This Contractor: The Electrical Contractor, also referred to as "The Contractor".

E. Provide: Furnish, install and wire complete and ready for service.

F. Exposed: Exposed to view in any room, corridor or stairway.

G. Code: National, State and Local Electrical codes including OSHA requirements.

H. Equals: Manufacturers or methods listed by name in the specifications, on the drawings or in an addendum are considered to be equals.

I. Substitution: Any manufacturer or method other than those listed by name in these specifications, on the drawings, or in an addendum.

J. NEC: National Electrical Code.

K. Signal Voltage: NEC class 1, 2, or 3 remote control, signaling or power limited circuits.

L. Low Voltage: 50 to 600 volts.

M. Medium Voltage: 601 to 35,000 volts.

N. High Voltage: 35,001 volts and greater.

## 1.4 PERMITS AND LICENSES

A. The Contractor shall prepare and submit all applications and working drawings, as required, to authorities having jurisdiction over the project. All licenses and permits required shall be secured and paid for by the Contractor.

B. Pay for all fees incident thereto.

C. Comply with local ordinances, laws, regulations and codes in effect at job site.

D. Pay all applicable taxes associated with electrical work.

## 1.5 STANDARDS AND CODES

A. All work shall be installed in accordance with National, State and Local codes, ordinances, laws and regulations. Comply with applicable OSHA regulations.

B. All materials shall have a UL or ETL label where a UL or ETL Standard and/or test exist.

## 1.6 DIMENSIONS AND DEFINITE LOCATIONS

A. The drawings depicting electric work are diagrammatic and show, in their approximate location, symbols representing electrical equipment and devices. The exact location of such equipment and devices shall be established in the field in accordance with instructions from the Architect and/or established by manufacturer's installation drawings and details.

1. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring electrical connections to verify rough-in and connection locations.
2. Unless specifically stated to the contrary, no measurement of an electric drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the electric drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

## 1.7 DRAWINGS

A. The Contractor shall keep a detailed up-to-date record, of the manner and location in which all installations are actually made, indexing each feeder, pull box and protective device.

B. As Built Drawings – See General Requirements – Division 1. The contractor shall provide final as-built (record) drawings at completion of project to the Engineer (electronic copy only) and Owner (full size hardcopy and electronic copy). Electronic files shall be in AutoCad 2008 format delivered on CD-R. The record drawings shall indicate device locations, equipment as-circuited, all interior feeder and significant branch circuit runs and junction boxes, exterior circuit runs and pull boxes. All interior feeders and exterior circuits shall include conductors/conduits installed information.

C. The engineer will make available to the contractor a complete set of electronic AutoCad files.

D. In the event of a conflict between the drawings and specifications, this Contractor shall base their bid on the greater quantity, cost or quality of the item in question, unless such conflict is resolved by an addendum. The Contractor shall be responsible for all existing field conditions, review existing field conditions prior to bid and shall take into account in bid proposal. No additional compensation will be allowed due to Contractor's failure to include all necessary work in the bid proposal.

E. Provide 100 percent complete and operational electrical systems and subsystems as specified herein and as shown on the drawings. Electrical systems shall include all materials, labor, taxes, mark-ups, overhead, profit, equipment, accessories and incidentals. All materials shall be new and not discontinued.

F. The drawings and specifications are schematic and scope in nature. All required light fixtures, devices, conduit, wiring, supports, etc., shall be included in the base bid to accommodate actual field conditions. Final locations of all electrical work shall be coordinated in the field and installed where directed by the Engineer. The Contractor shall follow the intent of the plans and specifications when bidding and completing the design of the required building electrical systems.

## 1.8 MATERIALS AND EQUIPMENT

A. All materials and equipment required shall be new.

B. All equipment supplied shall be based on materials and equipment of manufacturers specified. No substitutions will be allowed except as permitted in this specification.

C. All items specified shall be the latest type or model produced by the manufacturer specified. If descriptive specification or model number is obsolete, substitute the current product.

## 1.9 SUBSTITUTIONS

A. In any case where the Contractor wishes to use equipment or methods other than those listed by name, such equipment shall be considered a substitution and must be approved by the Engineer. To gain approval for substitutions, the Contractor shall submit the following to the Engineer for his review.

1. Documentation from the equipment manufacturer indicating where this equipment meets and does not meet the specifications or drawings as written. This documentation shall state all exceptions taken to the specification and the reasons for such exceptions. All documentation relative to the request for substitution shall be submitted on the manufacturer's letterhead and signed by a representative of the manufacturer.
2. Manufacturer's Cut Sheets: Cut sheets shall be originals as are contained in the manufacturer's catalog. Photocopies of these sheets will not be accepted for review (Furnish 3 copies).
3. Lighting Fixtures: Request for substitutions shall include photometric test reports performed by an independent testing laboratory.
4. The Contractor shall provide samples of the proposed equipment for the Engineer's review, if requested by the Engineer.
5. The Contractor shall furnish any other information or materials as requested by the Architect/Engineer to establish equality.
6. The Contractor shall acknowledge that they have reviewed the submission criteria for the request for substitution by stamping the submission with a review stamp or acknowledgment by an accompanying letter.
7. Equipment and materials submitted for review without proper documentation will be rejected without review.
8. A check for $400 to cover Engineer's time in reviewing substitution.

B. Any substitution submittal, including samples, shall be received in the Engineer's office a minimum of ten days prior to the Bid due date to allow adequate time for review.

C. Materials, equipment or methods of installation other than those named, will be accepted only if such articles are in accordance with the general requirements and are similar in composition, dimension, construction, capacity, aesthetics, finish and performance.

## 1.10 SHOP DRAWINGS AND EQUIPMENT BROCHURES

A. Submit to Engineer for review, the manufacturer's shop drawings and/or equipment brochures in quantities determined by the Architect for the following:

1. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
2. Section 26 05 33 - Raceways and Boxes for Electrical Systems
3. Section 26 05 73 - Overcurrent Protective Device Coordination Study
4. Section 26 22 00 – Low-Voltage Transformers
5. Section 26 24 16 – Panelboards (Include panelboard, substation and switchboard overcurrent devices with this submittal)
6. Section 26 27 26 – Wiring Devices
7. Section 26 27 28 – Disconnect switches (include related fuses with this submittal)
8. Section 26 29 00 – Low-Voltage Controllers
9. Section 26 36 23 – Automatic Transfer Switches (include remote annunciators)
10. Section 26 50 00 – Lighting Fixtures (including lamps)
11. Section 28 31 00 – Fire Detection and Alarm
12. Plans – Include equipment with related specification section submittal as indicated above.

B. Shop drawings shall be submitted in advance of construction and installation so as to not cause delay in other Contractor's work.

C. All data submitted for Engineer's review shall be numbered consecutively, shall be noted to correlate with the electrical drawings and shall bear:

1. The name and location of the project.

2. The name of the Contractor.
3. The date of submittal.
4. The date of the drawings and the date of each correction and revision.
5. If more than one type of lighting fixture (or other material) is on a submitted sheet, the proposed equipment shall be conspicuously checked with red pen by the Electrical Contractor.

D. Shop drawings for different systems and equipment shall be bound separately by specification section. Submittals which contain different systems bound together shall be returned un-reviewed for re-submittal.

E. The Contractor shall examine shop drawings and equipment brochures prior to submission. The Contractor shall verify that the materials and equipment depicted will properly fit into the construction. The Contractor shall also review all previously completed work related to the installation of the equipment depicted to insure that it has been properly installed.

F. The contractor is allowed up to two submittals for approval. If additional submittals are required for approval the contractor will be required to submit payment with certified check or money order in the amount of $250 with each section resubmitted to cover additional engineering time and mailing costs.

G. No materials or equipment subject to prior review by the Engineer shall be fabricated or installed by the Contractor, without approval. The Engineer's review of shop drawings shall not relieve the Contractor of responsibility for deviations from the requirements of the drawings and specifications, unless prior approval for such deviations has been granted.

## 1.11 MAINTENANCE MANUALS

A. The Electrical Contractor shall assemble and submit to the Architect for subsequent submission to the Owner, three complete sets of a Manual of Operation and Maintenance for each of the electrical and communications systems.

B. Each manual shall consist of a loose leaf bound volume instructing the Owner's personnel in the use, operation and maintenance of the system in question. The manual shall cover all phases of operation of the equipment and shall be illustrated with photographs, drawings, wiring diagrams, etc. Manuals shall accurately describe the operation, construction and adjustable features of the complete system and its component parts. The manual shall be complete with an equipment parts listing to facilitate the ordering of spare and replacement parts.

C. Each manual shall contain two sets of final shop drawings depicting equipment as installed.

## 1.12 CLEANING AND PAINTING

A. All rubbish resulting from this work shall be removed and disposed of on a daily basis in such manner as to be acceptable to the Architect.

B. The Contractor shall clean all exposed iron work, the interior and exterior of cabinets and pull boxes, etc., and remove all rubbish and debris resulting from the work.

C. Where painted surfaces of equipment have been damaged or rusted during construction, the Contractor shall paint same to match final.

D. Clean other equipment as indicated in other sections of the specification for specific equipment.

## 1.13 TESTS AND ACCEPTANCE

A. The operation of the equipment and electrical systems does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.

B. After the work is completed and prior to acceptance, the Contractor shall conduct the following tests, tabulate data, date, sign and submit to the Engineer.

1. Standard megger insulation test on each feeder.
2. Ground resistance test.
3. Clamp ammeter test on each feeder conductor with all utilization equipment energized. The load current in each phase conductor of the feeder or the portion thereof supplying the panel shall not differ from the average connected load currents in the feeder conductors by more than 7½ %. If the load currents in the feeder conductors by more than 7½ %, the Contractor shall change phase loading to same or receive written approval from the Engineer that this is not required due to the nature of the load.

C. Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction. The Contractor shall demonstrate that all work is complete and in perfect operating condition, with race way and conduit system properly grounded, all wiring free from grounds, shorts, and that the entire installation is free from any physical defects.

D. In the presence of the Engineer and the Owner, the Contractor shall demonstrate the proper operation of all miscellaneous systems.

E. Perform other test as specifically directed in other sections of the specifications for specific equipment.

## 1.14 GUARANTEE

A. All work shall be provided with a one year materials and labor warranty.
Warranty period shall begin after the Owner's final acceptance of the work.

B. See other Division 26 specification sections for equipment with extended warranties.

C. See General Conditions.

## 1.15 ACCESS PANELS

A. All access panels required by code or otherwise to electrical service equipment shall be supplied and installed by Electrical Contractor.

## 1.16 OWNER TRAINING

A. The contractor shall give the owner's personnel verbal and written operating instructions for all electrical systems.

## 1.17 COORDINATION BETWEEN TRADES

A. Coordination Meetings: Attend coordination meetings with the construction manager and all other trades for the purpose of coordinating the locations of all fire protection, plumbing, HVAC, kitchen, equipment and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field and to assure that all necessary power and control requirements are accounted for.

B. Conflicts Between Trades: Resolve all conflicts between trades at no additional cost to the Owner or Architect.

C. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of fire protection, HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.

D. Ceiling Grid Priority: Lighting fixture locations take priority over diffuser and sprinkler head locations.

## 1.18 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate and integrate the various elements of electrical systems, materials and equipment. Comply with the following requirements:

B. Coordinate electrical systems, equipment and materials installation with other building components, including transferring of ‘overlay’ plans to verify clearances, etc.

C. Verify all dimensions by field measurements.

D. Arrange for chases, slots and openings in other building components during progress of construction, to allow for electrical installations.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. All pipes passing through cast-in-place concrete walls and floors shall be sleeved.

F. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

G. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

H. Coordinate connection of electrical systems with exterior underground utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.

I. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown

only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

J. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

K. Install electrical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

L. Units concealed behind finished surfaces shall be installed behind an access panel or door as required.

M. Install systems, materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

**1.19 CUTTING AND PATCHING**

A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting and patching of electrical equipment and materials required to:

   a. Uncover Work to provide for installation of ill-timed Work.
   b. Remove and replace defective Work.
   c. Remove and replace Work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed Work as specified for testing.
   e. Install equipment and materials in existing structures.
   f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.

2. Cut, remove and legally dispose of selected electrical equipment, components and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
4. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installer's qualifications refer to the materials and methods required for the surface and building components being patched.
5. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

**PART 2 – PRODUCTS**

Not Used.

**PART 3 – EXECUTION**

Not Used.

END OF SECTION

## SECTION 26 05 02 - ELECTRICAL DEMOLITION FOR REMODELING

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable requirements of Division 1 shall govern work in this section.

### 1.2 JOB CONDITIONS

A. The existing building shall remain in service during construction. Power outages and interruptions in building systems shall be held to a minimum and shall be done at a time convenient to the Owner. The time of all outages shall be scheduled with the Owner and all other trades affected by the outage at least ten working days in advance. All demolition work shall be scheduled at periods and times acceptable to the Owner.

B. Refer to specification descriptions and plans for areas and equipment being remodeled.

C. Prior to demolition or alteration of structures, the following shall be accomplished.

1. Owner release of such structure.
2. Disconnection of electrical power to equipment and circuits removed or affected by demolition work.
3. Electrical services rerouted or shut off outside area of demolition.
4. Coordinate sequencing with Owner and other Contractors.
5. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition.

D. Notify utilities prior to razing operations to permit them to disconnect and remove and/or relocate any equipment that served existing facilities.

E. Contractor shall dispose of all obsolete material.

F. Contractor to reinstall salvaged materials as appropriate.

## PART 2 – PRODUCTS

Not Used.

## PART 3 – EXECUTION

### 3.1 ELECTRICAL SERVICE

A. Existing electric service to remain. Do not interrupt service or power inside building.

### 3.2 MODIFICATIONS

A. Feeders, branch circuits, and other system wiring which are to remain in service, but which are presently routed through areas being demolished shall be rerouted around demolition area.

B. **The contractor shall assume that there are additional existing conduits with conductors, cables, etc. as well as free air cabling in the project area that will require relocation as part of the project and shall include cost in project. No additional costs will be allowed for ignoring this requirement.**

## 3.3 REMOVAL

A. Electrical equipment in conflict with construction shall be removed or relocated as indicated on drawings, as directed, or as required.

B. Remove or relocate: Conduit, wire, boxes, fixtures that are in the way of construction.

C. Reconnect circuits and equipment to be continued in service.

D. Provide temporary wiring to any equipment that is to remain in operation during demolition and whose power would be interrupted as a result of demolition.

E. Remove electrical equipment released from service as a result of construction or as indicated on drawings.

F. Do not use removed electrical equipment except as specifically directly on the drawings.

## 3.4 DISPOSAL

A. Dispose of equipment that is removed unless specifically indicated on the drawings.

B. Raceway, conductors, boxes, cabinets and supporting devices shall become the property of the Contractor and shall be removed from the site and disposed of by the Contractor.

C. The Contractor shall tour demolition areas with the Owner to determine the status of all other equipment to be removed during demolition. All equipment that is to be salvaged for reuse by the Owner shall be removed by the Contractor and transported to an owner designated storage area on the site. The Owner shall be responsible for removal of salvaged equipment from the storage area.

## 3.5 LIGHTING FIXTURE BALLAST DISPOSAL

A. The Contractor shall inspect all ballasts in all light fixtures removed as part of this project and take the actions described below.

B. All ballasts labeled as “NON PCB’s” or “NO PCB’s” shall be handled as described in other sections of these specifications which describe demolition or salvage materials handling. If the PCB content is not stated on the ballast label, the ballast shall be handled as a PCB ballast.

C. All PCB ballasts shall have the wires clipped off and the ballasts placed in US DOT approved type 17C or type 17H barrels and placed in storage in a location within the building as designated by the Owner. The Contractor shall provide to the Owner, in typewritten form, a total count of these ballasts and where they are stored.

D. These ballasts are not to be removed from the work site by the Contractor.

E. The Contractor shall label and mark the PCB storage barrels with EPA approved PCB labels and shall mark the storage area with signs, marks and lines to meet the regulations of Wisconsin Code NR 157.

F. The Contractor shall provide approved PCB absorbent materials to be stored immediately adjacent to the barrel storage area. Do not place loose absorbent material in the barrels.

G. When the ballast demolition is completed and all PCB ballasts are placed in barrels ready to be picked up for disposal, the Contractor shall notify the Owner in writing so the Owner can make arrangements for pick up and disposal of the PCB ballasts.

## 3.6 LIGHTING FIXTURE LAMP DISPOSAL

A. The Contractor shall be responsible for the proper removal and recycling of all existing fixture lamps being removed from service in accordance with EPA and State of Wisconsin DNR requirements. Lamps shall not be disposed of in any way except as described herein.

B. The Contractor shall be responsible for arranging for recycling of lamps by a licensed waste lamp and bulb recycler. The cost for recycling of removed lamps shall be included in the Contractor's bid.

C. The Contractor shall carefully package removed lamps to prevent breakage. The Contractor shall store waste lamps in a secure area, either in the container that the lamps are shipped in or in other ways so as to eliminate breakage. Both the lamp storage area and individual containers should be labeled as hazardous waste. Store lamps in covered containers to prevent lamps from being broken as a result of other debris being placed on top of them.

## 3.7 ALTERATIONS

A. The Contractor shall be responsible for work of other trades to facilitate installation of electrical work in the existing building.

B. Work required by Electrical Contractor which is normally performed by other trades shall be done under direction and at the expense of Electrical Contractor.

END OF SECTION

## SECTION 26 05 04 - CLEANING, INSPECTION AND TESTING ELECTRICAL EQUIPMENT

### PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Prior to energizing equipment, retain services of a recognized independent testing contractor for purpose of performing inspections and tests herein specified.

B. Assure that electrical equipment is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.

### 1.3 ITEMS TO BE TESTED

A. Switchboards

B. Transformers

C. Circuit Breakers

D. Grounding Systems

F. Motor Starters

H. Standby Generator Systems

I. Automatic Transfer Switches

### 1.4 RELATED WORK

A. Section 26 05 26 – Grounding and Bonding for Electrical Systems

B. Section 26 24 16 – Panelboards

C. Section 26 29 00 – Low Voltage Controller

D. Section 26 36 23 – Automatic Transfer Switches

### 1.5 QUALITY ASSURANCE

A. Comply with the requirements of the following regulatory agencies:

1. National Fire Protection Association (NFPA) Chapter 70 - National Electric Code (NEC) and Wisconsin Amendments thereto.
2. Underwriters Laboratories (UL) Approval

B. Conform to the standards of the following agencies:

1. National Electrical Manufacturers Association (NEMA)
2. American Society for Testing and Materials (ASTM)
3. Institute of Electrical and Electronic Engineers (IEEE)

4. National Electrical Testing Association (NETA)
5. Insulated Power Cable Engineers Association (IPCEA)

C. Inspections and test shall utilize the following references:

1. Project design specifications.
2. Project design drawings.
3. Manufacturer's instruction manuals applicable to each particular apparatus.

## 1.6 TESTING AGENCY

A. Meet federal, state and local safety requirements for accreditation of testing laboratories, Title 29, Part 1907 membership in National Electrical Testing Association constitutes proof of meeting such criteria.

B. Meet Federal Department of Commerce requirements for nationally independent testing laboratory certification.

C. Permanently record checks and tests and make available to Engineer and Owner.

## 1.7 TEST REPORT SUBMITTALS

A. Seven copies of complete testing report.

B. Submit report no later than 30-days after completion of testing.

C. Submit proof of testing agency qualification.

## 1.8 JOB CONDITIONS

A. Electrical contractor's responsibilities.

1. Supply a source of test power to test laboratory at each test site.
2. Notify testing Subcontractor when equipment becomes available for acceptance tests.
3. Coordinate work to minimize project delay.
4. Supply a complete set of electrical drawings, specifications and pertinent change orders to testing contractor prior to commencement of testing.

B. Testing subcontractor's responsibilities.

1. Notify Engineer 72-hours prior to commencement of testing.
2. Provide material, equipment, labor and technical supervision to perform such tests and inspections.
3. Recommendations for acceptance or rejection shall be given upon consultation of Engineer, Owner, Contractor and testing laboratory's representative.

# PART 2 – PRODUCTS

Not Used.

## PART 3 – EXECUTION

### 3.1 GENERAL

A. Test work and equipment installed to ensure its proper and safe operation in accordance with intent of drawings and specifications.

B. Check interlocking and automatic control sequences and test operation of safety and protective devices.

C. Correct defects.

D. Cooperate with supplier's and manufacturer's representatives in order to achieve proper and intended operation of equipment.

E. Test, adjust and record operating voltages at each system level before energizing branch circuits.

F. Transformer taps must be adjusted to obtain as near as possible nominal system voltage.

G. Where transformer is under utility jurisdiction, obtain services of utility to correct voltage, if required.

H. Replace devices and equipment damaged due to failure to comply with this requirement.

I. Balance load among feeders conductors at each panelboard and reconnect loads as may be necessary to obtain a reasonable balance of load on each phase. Electrical unbalance shall not exceed 7½% between phases.

### 3.2 GENERAL INSPECTION AND CLEANING OF ALL ELECTRICAL EQUIPMENT

A. Inspect for physical damage and abnormal mechanical and electrical conditions.

B. Any item found to be out of tolerance, or in any other way defective as a result of the required testing, shall be reported to the Engineer. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.

C. Compare equipment nameplate information with the latest single line diagram and report any discrepancies.

D. Verify proper auxiliary device operation and indicators.

E. Check tightness of accessible bolted electrical joints. Use torque wrench method.

F. Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.

G. Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.

H. Clean All Equipment:
   1. Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, horizontal and vertical busducts, MCC's, fire alarm panels, comm/data, security panel, etc.
   2. Loosen attached particles and vacuum them away.
   3. Wipe all insulators with a clean, dry, lint free rag.
   4. Clean insulator grooves.
   5. Re-vacuum inside surfaces as directed by the Engineer or Inspector

I. Inspect equipment anchorage.

J. Inspect equipment and bus alignment.

K. Check all heater elements for operation and control.

L. Lubricate non-electrical equipment per manufacturer's recommendations.

## 3.3 GROUNDING SYSTEMS

A. Inspect the ground system for adequate termination at all devices.

## 3.4 DRY TYPE TRANSFORMERS

A. Test and adjust the cooling fans, controls and alarm functions.

B. Measure secondary voltage phase-to-phase and phase-to-ground after final energization and prior to loading.

C. Verify and/or connect transformer "XO" to ground, load side of "WYE" systems.

## 3.5 SWITCHBOARDS (LOW VOLTAGE)

A. Visual and Mechanical Inspection:
   1. Inspect for physical, electrical and mechanical conditions. Re-torque all bolted connections.
   2. Compare equipment nameplate information with latest single line diagram and report discrepancies.
   3. Inspect for proper alignment, anchorage and grounding
   4. All doors, panels and sections shall be inspected for paint, dents, scratches, and fit.
   5. Inspect cleanliness

B. Clean switchboard enclosure using the following methods:
   1. Loosen attached particles and vacuum them away.
   2. Wipe all porcelain with a clean, dry, lint-free rag.
   3. Clean all insulator grooves.
   4. Vacuum inside of switchgear enclosure
   5. Lubricate per manufacturer's recommendations.

C. All active components shall be exercised and cleaned where possible.

D. All indicating devices shall be inspected for proper operation.

## 3.6 CABLES

A. Visual and Mechanical Inspections:
   1. Inspect exposed sections for physical damage.
   2. Verify cable is supplied and connected in accordance with single line diagram.
   3. Inspect for shield grounding, cable support and termination.
   4. If cables are terminated through window type C.T.'s make an inspection to verify that neutrals and grounds are properly terminated for normal operation of protective devices.
   5. Inspect for visual jacket and insulation condition.
   6. Visible cable bends shall be checked against ICEA or manufacturer's minimum allowable bending radii -- 12 times the diameter for tape shielded cables.
   7. Inspect for proper fireproofing in common cable areas.
   8. There shall be NO tests performed on existing cable without specific direction from the Engineer.

B, Electrical Tests -- Below 600 Volts:
   1. All secondary cables from the substation transformers to the secondary switchboards shall be subjected to insulation tests using a 500 vdc megger.

2. Visually inspect cables, lugs, connectors and all other components for physical damage and proper connections
3. Check all cable connectors for tightness(with a torque wrench) and clearances. Torque test conductor and bus terminations to manufacturer's recommendations.
4. Check for proper grounding resistance at all services and at transformers. Resistance shall be 2 ohms maximum.

## 3.7 PANELBOARDS

A. Torque all the connections per the manufacturers spec. Verify phase wires, color coding, separate neutral and mechanical bonding. Verify circuit breaker operation. Verify the directory.

## 3.8 LIGHT FIXTURES

A. Check the bonding and proper lamping. Verify that recessed fixtures are installed with hold down clips. Confirm operation of the fixture with the proper switch or sensor.

## 3.9 OCCUPANCY SENSORS

A. Confirm operation of the sensor per the manufacturers spec.

## 3.10 BATTERY PACK EMERGENCY LIGHTING

A. Verify the operation per the manufacturers spec and run all of the diagnostic steps. Confirm proper grounding and location.

## 3.11 AUTOMATIC TRANSFER SWITCHES/GENERATOR/ANNUNCIATORS

A. Coordinate with the generator and the subsequent tests.

B. Run the generator through the standard tests as recommended by the manufacturer (not including a load bank test). Test the automatic and manual start circuits and run the full diagnostic tests.

C. Simulate a power failure including operation of the transfer switches, automatic cycle, and automatic shutdown and return to normal.

## 3.12 MOTOR STARTERS

A. Verify the control circuits. Confirm the fusing and the grounding of the control transformers. Torque all of the connections. Confirm the overload elements and the circuit breakers(fuse) for proper sizing. Verify all grounding. Operate and test each motor starter for proper operation.

B. Verify proper operation of pressurization systems and corresponding operation of realted fan motors.

END OF SECTION

## SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide conductors and connectors as specified herein.

### 1.3 RELATED WORK

A. Section 26 05 04 – Cleaning, Inspection and Testing Electrical Equipment

B. Section 26 05 26 – Grounding and Bonding for Electrical Systems

C. Section 26 05 33 – Raceway and Boxes for Electrical Systems

D. Section 26 05 53 – Identification for Electrical Systems

E. Section 26 27 26 – Wiring Devices

### 1.4 QUALITY ASSURANCE

A. Reference Standards of the following associations:

1. National Electrical Contractor's Association (NECA) – Standard of Installation.
2. Insulated Cable Engineers Association (ICEA).
3. National Fire Protection Association (NFPA) 70 – National Electrical Code (NEC) and Wisconsin amendments thereto.

## PART 2 – PRODUCTS

### 2.1 CONDUCTORS

A. Copper Conductor only.

B. Insulated with 600 V insulation and color code conductors for low voltage (secondary feeders and branch circuits) as required by code.

C. Type THHN Solid or Stranded: Single conductor No. 10 AWG and smaller, No. 12 AWG minimum.

D. Type THHN Stranded: Single conductor No. 8 AWG and larger. Conductor triple rated for use as types THHN, THWN and MTW is approved.

E. Conductors installed in exterior wet locations and areas with high humidity shall be type XHHW.

F. Conductors shall not be installed at temperatures below the manufacturer's minimum installation temperature.

G. Conductors used for generator start circuits shall utilize a shielded cable.

## 2.2 JOINTS, TAPS AND SPLICES

A. Interior Conductors No. 10 AWG and Smaller: Standard wire connectors.

B. Interior Conductors No. 8 AWG and Larger: NSI Polaris or equal Insulated multi-cable connector blocks.

C. Exterior Conductors No. 10 AWG and Smaller: King Silicon Filled ProLine Underground/direct bury rated wire connectors.

D. Exterior Conductors No. 8 AWG and Larger: Splices shall be accept (4) #14-#2 conductors, be underground/overhead rated and include gel filled hinged splice closure. Utilize NSI Easy-Splice Gel Tap Splice Kit series connectors (ESGTS-2) or equal.

# PART 3 – EXECUTION

## 3.1 INSTALLATION

A. Run conductors in conduit unless otherwise indicated on drawings.

B. Install in accordance with manufacturer's written instructions and in accordance with recognized industry practices.

## 3.2 INSPECTION

A. Examine areas and conditions under which feeders and branch circuits are to be installed and notify Engineer, in writing, of conditions detrimental to proper and timely completion of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

## 3.3 JOINTS, TAPS AND SPLICES

A. Cable splices shall be made only in distribution and junction boxes.

## 3.4 FIXTURE OUTLETS

A. Use conductor with insulation suitable for current, voltage and temperature to which conductor will be subjected.

B. No. 12 wire size minimum for conductors supplying power to a single fixture. 600V insulation minimum.

C. Insulation suitable for operation at 90° C. minimum for lighting fixtures with integral ballast, mogul base sockets, quartz lamps or otherwise where subject to excessive temperatures.

D. Fixture wiring shall be continuous wiring system to lampholder or to ballast and from ballast to lampholder.

## 3.5 FEEDER CIRCUITS

A. Extend feeders at full capacity from origin to termination.

B. Each conduit raceway shall contain only those conductors constituting a single feeder circuit.

C. Where feeder conductors are run in parallel, conductors shall be of same length, same material, circular-mil area, insulation type and terminated in same manner.

D. Where parallel feeder conductors shall be run in separate raceways, each raceway shall have same physical characteristics.

E. Feeders shall follow most accessible routes, concealed in construction in finished areas, exposed to the minimum temperature gradient and to minimum temperature fluctuation.

F. Confine feeders to insulated portions of building, unless otherwise specified.

G. Trapped feeder runs without facilities for continuous drainage are not acceptable.

H. Do not draw conductors into conduits until building is enclosed and watertight, and until work which may cause conductor damage has been completed.

I. Feeder conduits shall not be routed in concrete floor slabs.

## 3.6 BRANCH CIRCUITS

A. Conductors shall be size 12 AWG minimum (unless otherwise noted) for branch circuit wiring, including motor circuits.

B. Size 120V branch circuits for length of run on following basis:

1. 0 to 75 feet run from panelboard to first outlet: No. 12 AWG minimum.
2. 75 to 125 feet run: increase one wire size, i.e. No. 12 AWG becomes No. 10 AWG.
3. 126 to 200 feet run: increase two wire sizes, i.e. No. 12 AWG becomes No. 8 AWG.
4. 201 and above: wiring to be sized for 3% maximum voltage drop.

C. Size 277V branch circuits for length of run on following basis:

1. 0 to 100 feet run from panelboard to first fixture or outlet: No. 12 AWG minimum.
2. 101 to 200 feet run: increase one wire size, i.e. No. 12 AWG becomes No. 10 AWG.
3. 201 and above: wiring to be sized for 3% maximum voltage drop.

D. Provide individual neutral conductors for branch circuits serving isolated ground receptacles and computer equipment (No common neutrals for these circuits).

E. Voltage drop for branch circuits and feeder circuit combined shall not exceed requirements of NEC Article 215.

F. Route branch circuits and switch legs as dictated by construction, these specifications, or instructions from the Engineer.

G. Size conduit, outlet boxes and other raceway system components in accordance

with NEC requirements as minimum.

H. Do not draw conductor into conduits until building is enclosed and watertight, and work which may cause conductor damage has been completed.

I. Circuit numbers as shown on drawings are for Contractor to plan his wiring and for estimating purposes and are not necessarily the exact circuit numbers to be used in that panel for that particular load. Exact circuit numbers for each load are to be selected by the Contractor at their option. Balanced load on panelboard bus is to be the determining factor in arrangement of circuits. Panelboards average load shall not differ from phase to phase by ± 7-1/2%.

## 3.7 MOTOR AND EQUIPMENT WIRING

A. Furnish and install motor circuits in accordance with schedules on drawings and code requirements, from source of supply to associated motor starter, and from starter to motor terminal box, including necessary and required intermediate connections.

B. Conductor and conduit size for motor branch circuits, if shown on drawings, are sized for motor requirement only.

C. Motors shall have proper feeders as per NEC and nameplate ratings. Contractor is responsible for verification of ratings of motors and installing proper branch circuits.

D. Obtain manufacturer's wiring diagrams and shop drawings for equipment requiring electrical connections.

E. Check drawings and specifications of other divisions of work for equipment and work which shall be included in order to provide a complete electrical installation.

F. Motor connections shall be made by compression type connectors using proper tools and fittings to assure good electrical continuity and low resistance joint.

END OF SECTION

## SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide all material, labor and incidentals necessary for the completion of this section of the work.

### 1.3 RELATED WORK

A. Section 26 05 00 – Common Work Results for Electrical

B. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

### 1.4 QUALITY ASSURANCE

A. Follow the requirements of the following regulatory agencies:

1. National Fire Protection Association (NFPA, NFPA-70 - National Electrical Code (NEC) and Wisconsin amendments thereto.
2. Local Codes and Ordinances

### 1.5 REFERENCE STANDARDS

A. Conform to the standards of the National Electrical Contractors Association (NECA), Standard of Installation.

### PART 2 – PRODUCTS

### 2.1 GROUND CLAMPS

A. Ground clamp fittings shall be interlocking clamp type fabricated from high strength corrosion-resistant metal with high strength silicon bronze U-bolt, nuts and lock washers.

### 2.2 GROUND WIRES

A. Copper only.

B. Size as shown on drawings, or as required by NEC.

C. No. 6 AWG minimum.

### PART 3 – EXECUTION

### 3.1 GENERAL

A. Ground electrical systems and equipment as required by code, utility, local ordinances and to requirements herein.

B. Install separate code rated grounding conductors to special equipment and activity areas as required by code.

C. Bond all metallic piping systems and service equipment as required by NEC.

D. Cable connections and joints shall be thermo-welded.

## 3.2 EQUIPMENT GROUND

A. Bond metallic conduits, supports, cabinets and other equipment so ground will be electrically continuous from service to outlet boxes.

B. Install grounding conductor in nonmetallic and flexible conduit to complete equipment ground continuity. Ground wire shall be bonded at equipment and at first junction box of conduit system on line side of flexible conduit to the system.

C. Install grounding conductors to permit shortest and most direct path from equipment to ground. When grounding conductor runs through metallic conduit, bond to conduit at entrance and exit with a bolted clamp.

D. Ground neutral at service only.

E. Install an insulated equipment grounding conductor in each conduit. Conduit will not be relied upon as the grounding path.

F. Provide an insulated dedicated green equipment grounding conductor (in addition to equipment grounding conductor) with all circuits serving isolated ground receptacles (connected to isolated ground terminal on device).

G. Green ground bar in panels, where required to be similar to neutral bar, except tinted green and isolated from panel tub.

H. Connections shall be accessible for inspection and checking. No insulation shall be installed over ground connections.

I. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.

J. Attach grounds permanently before permanent building service is energized.

K. Ground metal lighting poles. Install a ground lug on wall of pole directly across from handhole.

L. Attach ground wire neatly and firmly to walls.

END OF SECTION

## SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable requirements of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide equipment for the support of electrical equipment as detailed or indicated on the drawings and as specified herein.

### 1.3 QUALITY ASSURANCE

Reference standards of the following agencies:

A. National Electrical Contractors Association (NECA), Standard of Installation.

B. National Electrical Manufacturers Association (NEMA).

C. American National Standards Institute (ANSI).

### PART 2 – PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. Kindorf

B. Elcen Co.

C. Steel City

D. Unistrut

E. B-Line

### 2.2 GENERAL

A. Metal supporting devices shall be zinc galvanized or cadmium plated steel or malleable iron.

### 2.3 LIGHTING FIXTURE SUPPORT

A. Items such as stems, hickeys, bar hangers and clips required to securely attach fixtures to ceilings or walls.

B. Studs and unistrut support for fixture outlet and ceiling support.

C. Fixture grid hangers for mounting surface fluorescent units to exposed grid ceiling.

D. Drilled expansion insert type anchors suitable for load and application requirements such as sleeve anchors, lag shields, and plastic anchors.

E. Provide auxiliary supports so that fixtures can be drawn up tightly, cannot be tilted or rotated and will not be affected by vibrations.

## 2.4 SUPPORTING STRUCTURES

A. Rack supports of galvanized steel channel sections with adequate feet to allow secure mounting.

B. Weld sections, do not use bolts.

## 2.5 MOUNTING PANELS

A. Size mounting panels to mount necessary equipment, of ¾" exterior grade plywood as specified on drawings.

B. Provide mounting panels for all surface mounted electrical cabinets and enclosures.

C. Provide uniform mounting panels as far as practical. Preferred sizes being 12" X 18", 18" X 24", 18" X 30", and 24" X 30".

## 2.6 CONDUIT SUPPORTS

A. Two hole galvanized steel straps.

B. Continuous slot or T-slot galvanized steel concrete insert channel.

## 2.7 TRANSFORMER MOUNTING BRACKETS

A. Provide mounting brackets fabricated of welded galvanized steel channel section.

B. Design bracket to support the size transformer as indicated on drawings.

# PART 3 – EXECUTION

## 3.1 PREPARATION

A. Install hangers, supports and anchors only after structural work, where work is to be installed, has been completed. Correct inadequacies such as proper placement of inserts, anchors and other building structural attachments.

B. Examine areas and conditions under which equipment and associated components are to be installed and notify Architect, in writing, of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

## 3.2 LIGHTING FIXTURES

A. Install channel supports across main grid runners or grid supports, securely tied down or anchored for fixtures and devices mounted in suspended ceiling systems so as not to cause tile to sag and so that fixture or device cannot be lifted, rotated or displaced. Provide additional support of ceiling grid or tees at those locations where tiles and ceiling grid sags.

B. Install grid troffer support clips in accordance with NEC 410-16(c).

## 3.3 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on to structural steel or raceway and equipment support.

B. Install additional building attachments where support is required for additional concentrated loads.

C. Install concrete inserts before concrete is placed

## 3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment.

B. Installation methods shall conform with the manufacturer's recommendations for maximum holding power, but in no case shall the depth of hole be less than four bolt diameters. Minimum distance between the center of any expansion anchor and an edge of exterior corner of concrete shall be not less than 4½ times the diameter of the hole in which it is installed.

## 3.5 SUPPORT OF CONDUIT

A. Fasten conduit to structural parts of building in a manner acceptable to Engineer.

B. Do not use perforated hanger iron.

C. Install concrete insert channel as required, with spacings as recommended by manufacturer. Install with anchor and caps, insert joiner clips and closer seals as required.

D. Support conduit as follows:

1. Single Conduit Runs
   a. Vertical Surfaces: Galvanized, heavy duty, sheet steel straps; back straps to be provided for all exposed conduit and conduit on exterior walls.
   b. Horizontal Surfaces: Galvanized, heavy duty, 2-hole steel pipe straps.
2. Multiple Conduit Runs
   a. Vertical Surfaces: Horizontal or vertical rack channel with conduit straps as required.
   b. Horizontal Surfaces: Single or double rack channel trapeze, complete with conduit straps as required; all supported with threaded hanger rods.
3. Passing Between Floors and Through Roof
   a. 1¼ " and larger conduit runs passing through floors shall be supported at each floor with riser pipe clamps.
   b. Conduit extending through roof shall pass through a ceiling box at roof lines.
   c. Provide 14 ga minimum copper box complete with watertight soldered seams and flanged to serve as pitch pocket for each conduit.
   d. Conduit and pitch pocket shall be installed in advance of roofing work.

## 3.6 VERTICAL CABLE SUPPORT

A. Conductors in vertical raceways shall be supported using suitable cable supports. Locate supports so that each 25 ft.-0 in. length of conductor in a vertical raceway will be complete with support.

## 3.7 TRANSFORMER SUPPORTS

A. Install auxiliary transformer wall mounting brackets where all wall mounted transformers are indicated on drawings.

END OF SECTION

## SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide conduit systems, boxes and fittings for all power wiring and communication systems as specified.

### 1.3 RELATED WORK AND REQUIREMENTS

A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 05 26 – Grounding and Bonding for Electrical Systems

C. Section 26 06 29 - Hangers and Supports for Electrical Systems

D. Section 26 27 26 – Wiring Devices.

### 1.4 QUALITY ASSURANCE

A. National Electrical Contractor's Association (NECA) Standard of Installation

B. National Electrical Code (NEC) including State of Wisconsin and local supplements.

## PART 2 – PRODUCTS

### 2.1 GALVANIZED RIGID CONDUIT (GRC) AND INTERMEDIATE METAL CONDUIT (IMC)

A. Manufactured lengths, full weight, heavy wall, rigid steel conduit, protected inside and out by hot-dipped galvanized or electro-galvanized coating.

B. Minimum conduit size shall be ½ inch.

C. Connectors and Couplings
   1. Threaded.
   2. Liquid tight.
   3. Insulated throat.

### 2.2 ELECTRICAL METALLIC TUBING (EMT)

A. Standard lengths and sizes.

B. Minimum conduit size shall be ½ inch.

C. Connectors and Couplings
   1. Threaded with insulated throat for box connections.
   2. Gland compression on conduit connections.
   3. Steel.

D. Colors (factory finished):
   1. Red – Fire Alarm Systems
   2. Green – Emergency power systems.
   3. Purple - Security
   4. Blue - Telecommunications
   5. Standard Silver (No special finish) - Normal power systems

## 2.3 POLYVINYL CHLORIDE CONDUIT (PVC)

A. Standard lengths and sizes.

B. Minimum size ½“, with the exception that the minimum size conduit for underground site lighting circuits shall be 1”.

C. Schedule 40, heavy wall rigid plastic (PVC) conduit manufactured to NEMA TC-2 standards, UL listed and as required by NEC. Sunlight resistant.

D. Connectors and Couplings

   1. To match conduit.

E. PVC conduit is NOT allowed to be run in any area that is in direct sunlight.

## 2.4 PVC COATED RIGID METAL CONDUIT

A. Per NEMA Standards Publication No. RN 1 – 1980 and ANSI C80.1.

B. Rigid steel galvanized conduit with PVC coating.

C. Full weight 40 mil thick PVC coating, bonding to galvanized metal shall be stronger than plastic tensile strength.

D. Minimum conduit diameter shall be ½ inch.

E. Connectors and Couplings

   1. Full weight 40 mil PVC jacket.
   2. PVC gasketed for mating surfaces.
   3. Same as for rigid conduit.

## 2.5 FIBERGLASS CONDUIT

A. Per UL 1684, rigid conduit and associated condulets and fittings shall be carbon black reinforced thermosetting resin suitable for above ground installation.

B. Minimum conduit size shall be ¾ inch.

C. Connectors and Couplings

   1. To mach conduit.

## 2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Galvanized spiral strip flexible steel.

B. Standard conduit sizes.

C. Heavy wall sunlight resistant PVC jacket.

D. Minimum size ½ inch.

E. Connectors and Couplings

1. Liquid-tight.
2. Suitable for grounding.
3. Suitable for wet locations.
4. Tapered threaded hub.
5. Non-metallic materials.

## 2.7 FLEXIBLE METAL CONDUIT

A. Galvanized spiral strip flexible steel.

B. Standard conduit sizes.

C. Minimum size ½" with the exception that 3/8" diameter may be used to serve individual lighting fixtures installed in a suspended accessible ceiling system.

D. Connectors and Couplings

1. Threaded.
2. Grounding type.
3. Insulated throat.
4. Two screw clamp type with locknuts.
5. Externally secured.

## 2.8 SURFACE METAL RACEWAYS

A. Raceways shall be two piece. Front cover shall be removable to provide access to wiring compartment.

B. Raceways shall be galvanized steel.

C. Raceways shall be provided with multiple knockouts and screw holes along back channel.

D. All additional accessories required for a complete installation shall be provided.

E. Raceways shall be ivory.

F. Raceway Types

1. Wiremold 500 Series minimum, or approved equal, to feed individual power and/or telecommunications wiring devices.
2. Wiremold 4000 Series or approved equal: Shall not be less than 4-3/4" x 1-3/4" in size. Where plans call for telecommunications and power wiring to be run in the same raceway, the raceway shall be provided with a metal barrier. 4000 raceway shall be used wherever the multi- receptacle assembly symbol is shown on the floor plans.

## 2.9 EXPANSION FITTINGS

A. Expansion fittings: Copper bonding jumper, Crouse-Hinds Type XJ.

B. Expansion/deflection fittings: Copper bonding jumper, Crouse-Hinds Type XD.

## 2.10 CONDUIT BODIES

A. Galvanized or cadmium plated.

B. Threaded hubs.

C. Removeable cover with gasket.

D. Corrosion-resistant screws.

## 2.11 SEALS

A. Wall entrance seals: Link seal type as manufactured by Thunderline Corporation.

## 2.12 INTERIOR WALL OUTLET BOXES – FLUSH MOUNTED

A. Stud wall construction. Stamped steel, four-inch square, 2-1/8" deep, with square corners. Provide with raised device rings, height as required for wall finish thickness. Mounting accessories as required. Larger width boxes as required for ganging requirements indicated on plans.

B. Masonry wall construction. Stamped steel. Face of box flush with wall, 3-1/2" deep box minimum. Width as required for ganging requirements shown on plans.

## 2.13 INTERIOR WALL OUTLET BOXES – SURFACE MOUNTED – DRY LOCATION

A. In public areas: Cast malleable aluminum with threaded conduit hubs. Two inches deep minimum. Internal mounting ears. Boxes shall be coated with electroplated zinc, a dichromate coating and an aluminum polymer enamel finish.

B. Other areas: Stamped steel, four-inch square, 2-1/8" deep, with round corners. Provide rounded corner raised box covers with openings as required for devices being installed.

## 2.14 INTERIOR WALL OUTLET BOXES-SURFACE MOUNTED-DAMP OR WET LOCATION

A. Cast malleable aluminum with threaded conduit hubs. Two inches deep minimum. Internal mounting ears. Boxes shall be coated with electroplated zinc, a dichromate coating and an aluminum polymer enamel finish.

## 2.15 EXTERIOR WALL OUTLET BOXES - SURFACE MOUNTED

A. Single or two gang as indicated on the plans. Cast malleable iron with threaded conduit hubs. Two inches deep minimum. Internal mounting ears. Boxes shall be coated with electroplated zinc, a dichromate coating and an aluminum polymer enamel finish.

## 2.16 CEILING BOXES - FLUSH MOUNTED - FOR SURFACE AND PENDANT LIGHT FIXTURES

A. Dropped ceiling construction. Stamped steel four-inch octagon box set flush with finished surface, complete with 3/8" fixture stud.

B. Cast in place concrete construction. Stamped steel four-inch octagonal, galvanized concrete boxes, having a minimum depth of 3”, complete with 3/8” fixture stud.

## 2.17 ELECTRICAL BOXES IN CORROSIVE LOCATIONS

A. PVC coated cast steel boxes compatible with conduit system installed. Coating shall cover both interior and exterior surfaces. See floor plans for identification of corrosive areas.

## 2.18 SPECIAL BOXES

A. Provide special boxes fabricated by the manufacturer of fixtures and other devices where standard outlets are not applicable.

## 2.19 INTERIOR GENERAL PURPOSE JUNCTION AND PULL BOXES

A. Fabricated from code gauge galvanized steel with covers held in place by corrosion resistant machines screws.

B. Size as required by code for number of conduits and conductors entering and leaving box.

C. Provide with welded seams, where applicable and equip with corrosion-resistant nuts, bolts, screws and washer.

## 2.20 ACCESS PANELS

A. Furnish type necessary for the particular wall or ceiling construction in which they occur.

B. Panels to be completed with screwdriver cam locking device.

## 2.21 FLOOR BOXES

A. Provide Walker Omnibox multiservice floor boxes with activations and gangs as needed. The box shall be cast iron with four threaded adjustment legs, Provide brass cover plate flanges, brass (screw locking flip type lid) cover plates, receptacle(s) and communication activation bezels as appropriate. Provide assembly that is rated for the 2003 UL scrub water standards.

B. Provide other floor boxes as listed on the plans.

## 2.22 EXTERIOR JUNCTION BOXES

A. Stainless steel or cadmium plated malleable iron cast type with threaded hubs, cast cover and neoprene gasket. Provide NEMA 4X rating.

## 2.23 BETWEEN STUD BOX SUPPORT BRACKETS

A. Stamped and fabricated steel bracket designed to support 4” or 4-11/16” electrical boxes between wall studs.

B. Manufactured by Erico, RBS series or equivalent.

## 2.24 EXTERIOR PULL BOXES

A. Pull boxes shall be constructed of a composite material as shown on the plans. The composite boxes shall be constructed of polymer concrete and reinforced by a heavy-weave fiberglass as manufactured by Quazite or approved equal. The pull boxes shall be rated for 15,000 lbs. over a 10" x 10" area at a temperature of -50°F and be UL listed.

B. The box shall be furnished with a cover having a skid resistant surface with a minimum coefficient of friction of .5 and concrete gray color. The cover fasteners shall be stainless steel captive 3/8-inch hex head bolts with stainless steel inserts. The cover for the pull box shall have an “ELECTRIC”, “LIGHTING” or “COMMUNICATIONS” logo corresponding with system, unless otherwise noted on the plans.

# PART 3 – EXECUTION

## 3.1 GENERAL

A. Interior conduits for wiring systems rated 0 to 600 volts shall be electrical metallic tubing (EMT). Exceptions to the requirements stated above are as follows.

1. Poured concrete: PVC.
2. Motor connection: Flexible conduit of appropriate type.
3. Hazardous and corrosive locations: PVC coated Rigid Metal Conduit.
4. Corrosive locations only: PVC.
5. Damp/wet areas (i.e. crawl spaces): PVC.
6. Areas subject to damage shall (i.e. loading docks): GRC.
7. Where otherwise stated in these specifications or on the floor plans.

B. Interior conduits for wiring systems rated over 600 volts shall be intermediate electrical conduit (IMC). Exceptions to the requirements stated above are as follows.

1. Over 15kv: GRC
2. Poured concrete: PVC.
3. Motor connection: Flexible conduit of appropriate type.
4. Hazardous and corrosive locations: PVC coated Rigid Metal Conduit.
5. Damp/wet areas (i.e. crawl spaces): PVC coated Rigid Metal Conduit.
6. Areas subject to damage shall (i.e. loading docks): GRC.
7. Where otherwise stated in these specifications or on the floor plans.

C. Exterior underground conduits, service entrance conduits and conduits embedded in concrete lighting fixture pole bases shall be heavy wall schedule 40 PVC except as follows:

1. Underground conduit runs which enter or exit the building envelope shall utilize galvanized rigid conduit from the point of penetration of the building envelope and the next 5’ portion of the run in direct contact with the earth. Where conduits pass through poured concrete walls the EC shall install sleeves prior to the walls being poured.

D. Conduits below the building slab shall be heavy wall schedule 40 PVC.

1. When PVC conduit is stubbed-up above the slab, it shall only extend between 4”-6” above the top of the slab and be transitioned to the appropriate conduit allowed.

E. Conduits encased in concrete as part of an underground electrical duct package shall be Schedule 40 HW PVC except that conduits shall be PVC coated rigid galvanized steel within 5' of the building envelope or for bends greater than 30 degrees.

## 3.2 UNDERGROUND CONDUIT

A. Exterior underground conduit shall be buried at a depth of not less than 24 in., nor more than 36" below grade or pavement.

B. Provide conduits or ducts terminating below grade with means to prevent entry of dirt or moisture.

C. Underground conduits shall slope 1/8" per foot for proper drainage. Conduits shall drain toward manholes and junction boxes, not the electrical equipment.

## 3.3 PROCEDURES AND PRACTICES

A. All conduits shall be routed concealed in finished spaces and shall not be visible at any point within the finished space or from the building's exterior. This requirement also applies to new conduits installed in existing construction. Exposed raceway may be used only where physically impossible to route concealed in construction. In such cases where exposed raceway is allowed it shall be surface type in public areas as dictated by the wiring quantities. In each case the specific raceway type and routing shall be submitted to the Architect for approval. Where allowed, the general installation requirements are as follows:

1. Raceways shall be routed horizontally along the corners of walls and ceilings, directly above edges of base molding at floors, or along the tops of window and door frames.
2. Raceways shall be routed vertically along corners of adjacent walls and along the edges of window and door frames.
3. Raceways shall not be routed down or across open wall surfaces except in portions of runs not exceeding 12" in length.
4. Raceways shall be painted to match wall finishes. EC is responsible for painting of all raceways.
5. Fittings and boxes used with raceways shall be specifically designed and approved for use with the raceways.

B. Cut joints shall be square, reamed smooth and drawn up tight.

C. Keep conduit plugged, clean and dry during construction.

D. Cap spare conduits.

E. Provide riser clamps around all conduits 1-1/4" or larger that are routed between floors. Provide conductor support in vertical risers greater than 20' as appropriate.

F. Provide a watertight conduit system where installed in wet locations such as underground, or where embedded in concrete.

G. Route conduit runs above suspended acoustical ceilings so as not to interfere with ceiling tile removal. Conduit supports shall be attached to building structural elements. Conduits shall not be supported by or attached to the suspension systems for dropped ceiling systems unless specifically detailed on the drawings.

H. Conduits may be routed exposed in mechanical equipment rooms and utility rooms.

I. Route all conduits (including conduits routed above ceilings) parallel to or at right angles with lines of the building construction and structural members except conduit runs routed concealed in pour-in-place concrete floor slabs may be run in direct line from source load.

J. Make bends and offsets without kinking or destroying smooth bore of conduit. Arrange bends and offsets in parallel conduits to present a neat symmetrical appearance.

K. Secure conduits in place with malleable corrosion-proof alloy straps or hangers. Conduit straps used in corrosive areas shall be PVC coated.

L. The use of perforated strapping as a conduit hanging method is not approved.

M. Conduit runs that extend through areas of different temperature or atmospheric conditions shall be sealed, drained and installed in a manner that will prevent drainage of condensed or entrapped moisture into cabinets and equipment enclosures.

N. Route conduits within poured concrete construction parallel to each other and spaced on center of at least three times conduit trade diameter with minimum two (2) inches of concrete covering. Conduits over 1 ¼" may not be installed in slab without the approval of the Architect. Conduits embedded in a structural frame slab shall comply with applicable provisions of American Concrete Institute (ACI), Standard 318. Conduits used for feeders shall not be embedded in concrete floor slabs.

O. In areas constructed of pre-cast concrete, run conduits in insulation space or in floor topping slabs without crossing other conduits, using ¾" maximum conduit size.

P. Install flexible steel conduit whips from an independent junction box mounted above ceiling to recessed ceiling mounted lighting fixtures. Allow for positioning of equipment to tile increments.

Q. Connections to Motors and Equipment Subject to Vibration:

1. Flexible steel conduit not over three (3) feet long for connection to motorized equipment.
2. Liquid-tight flexible conduit not over three (3) feet long where exposed to moisture, dirt, fumes, oil, corrosive atmosphere with connectors to assure a liquid-tight, permanently grounded connection. Locate so it is least subject to physical abuse. Corrosive areas are identified on the floor plans.
3. Use double locknuts and insulated bushings with threads fully engaged.

R. Install bushings with ground lugs and integral plastic linings at equipment with open bottom conduit entrances.

S. Install conduit expansion fittings where conduits cross expansion joints.

T. Install No. 12 pull wire in empty conduit.

U. All wiring in raceways shall be provided with a separate green grounding conductor.

V. All conduits that terminate in free air (no connection to equipment or box) shall be provided with an insulated bushing.

W. All wiring in walls shall have a raceway within the wall with an enclosed outlet box regardless if the remaining portion of the particular system is installed in raceway or free-air.

## 3.4 FIRE STOPS AND PENETRATION SEALS

A. All penetrations through fire rated floors and walls due to the electrical installation shall be sealed with CHASE-FOAM PR-855 Fire Resistant Foam Sealant, to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after a fire. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or was is maintained as required by Article 300-21 of the National Electrical Code. Equivalent foam sealant manufactured by Dow Corning approved.

B. The sealant shall remain soft and pliable to allow for the removal and/or addition of cables without the necessity of drilling holes. It shall adhere to itself perfectly to allow any all repairs to be made with the same material. It shall permit the vibration, expansion and/or contraction of anything going through the penetration without the seal cracking or crumbling.

C. When damming materials are to be left in place after the seal is complete then all such materials shall be non-flammable.

D. When sealant is injected into a penetration, the foam shall expand to surround all the items within the penetration and maintain pressure against the walls of the penetration. The foam shall cure with in five minutes and be fire resistant at that time. No heat shall be required to further expand the foam to block the passage of fire and smoke or water.

E. All wall or floor penetrations openings shall be as small as possible.

F. The foam sealant shall meet all fire test and hose stream test requirements of ASTM E119-73 and shall be UL Classified as a Wall Opening Protective Device.

G. All penetrations through non-fire rated walls shall be sealed with an appropriate sealant.

## 3.5 CUTTING AND PATCHING

A. Provisions for opening, holes and clearances through walls, floors, ceilings and partitions shall be made in advance of construction.

B. Provide cutting, patching and painting necessary for the installation of electrical systems.

C. Where conduits need to penetrate concrete or masonry construction below grade, the EC shall install PVC sleeves with integral waterstop, one (1) inch larger in diameter than the conduit being installed. Install sleeves before walls and/or slabs are poured or constructed.

D. Where conduits need to penetrate concrete or masonry construction above grade, the EC shall install 22 gauge galvanized steel pipe sleeves, one (1) inch larger in diameter than the conduit being installed. Sleeves shall extend 2” above and below the floor slab penetrated. Install sleeves before walls and/or slabs are poured or constructed.

E. The Electrical Contractor shall prepare drawings indicating size and location of all anticipated floor sleeves for the installation of electrical conduits. Such drawings shall be made available to the General Contractor 10 days prior to any scheduled concrete work.

## 3.6 RESTRICTIONS

A. Conduits routed parallel to steam lines, hot water pipes, high temperature piping or ducts shall be routed at least 12” from such and shall be a minimum of 12” clear when crossing same.

B. Do not route conduit over boiler, incinerator or other high temperature equipment.

C. Where conduits must cross or follow the same path as water, steam or other fluid piping, run electrical conduits above such piping wherever possible.

## 3.7 ADJUSTMENT AND CLEANING

A. Restore damaged areas on PVC jacketed, rigid conduit with spray type touch-up coating compound or as directed by manufacturer.

B. Pull cleaning plug through conduits to clear of dirt, oil and moisture.

## 3.8 CONDUIT SYSTEMS

A. Where raceways are required, separate raceway systems shall be provided for each wiring system as follows:

1. 208 volt normal power wiring systems.
2. 208 volt code required emergency power wiring systems.
3. 480 volt normal power wiring systems.
4. 480 volt code required emergency power wiring systems.
5. Signal voltage lighting control systems.
6. Fire alarm systems.
7. Voice/data communications raceway systems.
8. Lighting control systems.

## 3.9 CONDUIT FITTINGS

A. Install electrical fittings in accordance with the manufacturer’s written instructions and with recognized industry practices to ensure that fittings serve intended purposes.

B. Rigidly secure connectors at cabinets and boxes with galvanized lock nut and bushing.

C. Seal conduits that run through different temperature or atmospheric conditions to prevent condensation or moisture from entering electrical equipment and devices.

D. Install wall entrance seal where conduits or direct burial conductors pass through foundation walls below grade.

E. Install conduit expansion fittings complete with bonding jumper in following locations:

1. Conduit runs which cross a structural expansion joint.
2. Conduit runs where movement perpendicular to axis of conduit may be encountered.

F. Locate conduit bodies so as to assure accessibility of electrical wiring.

G. Install fittings designed for use with flexible liquid-tight conduit to ensure continuity of ground throughout the fittings and conduit, and prevent entrance of moisture.

H. Exposed PVC runs, subject to temperature changes of more than 20 degrees, and longer than 10 feet shall have an expansion fitting (long or short type as appropriate) installed in middle of run.

## 3.10 BOX INSTALLATION

A. Install electrical boxes as indicated in compliance with NEC requirements, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes serve the intended purposes.

B. Seal conduit at entrance to weatherproof boxes for interior and exterior locations exposed to weather or moisture.

C. Install knockout closures to cap unused knockout holes where blanks have been removed.

D. Locate boxes so as to assure accessibility of electrical wiring. Relocate boxes rendered inaccessible by the installation of work by other trades.

E. Secure boxes rigidly to the substrate upon which they are being mounted or solidly embed boxes in concrete or masonry. Do not support from conduit.

F. Set boxes, in concealed conduit runs, flush with wall surfaces, with or without covers, as required.

G. Do not install boxes back to back or through wall. Offset outlet boxes on opposite sides of wall a minimum of 12 inches.

H. Set outlet boxes parallel to construction, securely mounted and adjusted to set true and flush with the finished surface.

I. Do not burn conduit holes, use knock-out punches or hole saws.

J. Use "no-bolt" studs where specifically detailed on the drawings.

K. Boxes shall be sized per code to accommodate the number and size of conduit entrances to the box and to accommodate the number of conductors, splices, fittings, etc., within the box. Do not use box extensions to create additional volume to meet NEC requirements for the number of conductors contained in a box.

## 3.11 EXPOSED OUTLET AND JUNCTION BOXES

A. Install non-rusting metal weatherproof cover on recessed junction box in new walls or non-rusting surface mounted metal junction boxes on existing walls outdoors and in any area where drawings show weatherproof (WP) or weatherproof-while-in-use (WPIU) wiring devices. Provide non-rusting metal WPIU covers anywhere required by code, even if not indicated on plans.

## 3.12 INTERIOR OUTLET BOX ACCESSORIES

A. Provide outlet box accessories as required for each installation, such as mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.

## 3.13 LIGHTING FIXTURE OUTLET BOXES

A. Securely mount with approved type bar hangers spanning structural members to support weight of fixture.

B. Do not support from conduit.

C. Equip with 3/8” fixture studs and tapped fixture ears for surface mounted or pendant mounted lighting fixtures. Fixture studs shall be provided for mounting of all lighting fixtures exceeding 25 lbs in weight. Fixture studs shall be attached through knockouts at the top of the box.

D. Provide additional attachments from structure for outlet boxes supporting lighting fixtures weighting in excess of 25 lbs.

## 3.14 OUTLET BOX LOCATIONS

A. Locate flush mounted wall boxes in corner of nearest brick or block to keep cutting to a minimum.

B. Location of outlets and equipment as shown on drawings is approximate, and exact location is to be verified and shall be determined by:

1. Construction or code requirements
2. Conflict with equipment of other trades.
3. Equipment manufacturer’s drawings.

C. Where receptacles and communication outlets are shown grouped next to each other on the drawings, the boxes for these outlets shall be mounted next to each other and shall not be located according to stud spacings. The Contractor shall utilize between stud box supports to assist in mounting boxes proximal to one another on a consistent spacing between wall studs.

D. Minor modification in the location of outlets and equipment is considered incidental up to a distance of 10 feet, provided the change in location is requested prior to rough-in. **Outlets shall not have their locations significantly altered from that shown on the plans unless approved by the engineer – relocations necessary to relocate and install in the intended position due to unapproved relocations shall be at the sole cost to the electrical contractor.**

E. Mounting heights for devices and equipment to be measured from finished floor to center line of device.

END OF SECTION

## SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SECTION INCLUDES

A. Nameplates

B. Labels

### 1.3 RELATED WORK

A. Section 26 05 00 – Common Work Results for Electrical

## PART 2 – PRODUCTS

### 2.1 MATERIALS

A. Nameplates:

1. Engraved three-layer laminated plastic, white letters on a black background. Emergency system shall use white letters on a red background.

B. Tape (phase identification only):

1. Scotch #35 tape in appropriate colors for system voltage and phase.

C. Adhesive type labels shall be typed with black text on white background for boxes in non-public areas and black text on clear background for wiring device faceplates.

D. Embossed tape is not permitted.

## PART 3 – EXECUTION

### 3.1 GENERAL

A. Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system shall be labeled for voltage in addition to the other requirements listed herein.

B. All branch circuit and power panels shall be identified with the same name used at the main distribution panel.

C. Handwritting is not acceptable for any identification, including any additional identification required by inspectors or other code officials.

### 3.2 INSTALLATION

A. Clean and degrease surfaces to receive labels or nameplates.

B. Install nameplates parallel to equipment lines.

C. Secure nameplates to equipment using screws, rivets or adhesive.

D. Provide nameplate for each switchboard, panelboard, contactor, telephone cabinet, time switch, motor starter, transformer, fire alarm panel or disconnect switch.

1. Identification shall be on the exterior of the unit, except for flush equipment in public areas which shall have the identification inside the door or cover.

E. Label each end of empty conduit runs to indicate the use of the conduit and the location of opposite end and plug conduit ends. Use room numbers that are permanently assigned.

## 3.3 EQUIPMENT IDENTIFICATION

A. TYPICAL EQUIPMENT

1. Identify using nameplates for lighting and appliance panelboards, motor starters, disconnect switches, timeclocks, contactors, remote control stations, fire alarm panels, lighting control panels, TVSS's and transformers: ½ inch: identify equipment designation (upper line); ¼ inch: identify voltage rating and source (lower line).

B. SWITCHBOARD and POWER PANEL (I-Line type) IDENTIFICATION

1. Provide an identification nameplate mounted at the top of the main section. Nameplate shall include in 1" text the switchboard designation as shown on the plans and in ½" text the switchboard voltage, interrupting rating and bus rating.
2. Overcurrent devices (CBs) in the switchboard shall be identified by nameplates, with ½" text, as to the load served. Nameplate shall be located adjacent to the feeder device. Load served shall be the next equipment downstream (panelboard, transformer, transfer switch, etc.). Where the load served is a motor or other piece of equipment, the Specifier's designation or other description (ex. Elevator #1) shall be used in lieu of the motor number or special outlet number shown on the electrical plans. Spare devices shall be identified as such.

## 3.4 JUNCTION BOX/PULL BOX IDENTIFICATION

A. Junction Boxes and Pull Boxes for power distribution systems:

1. Normal Power: Cover shall indicate voltage using ½" text; source(s) and circuit(s) contained within using ½" text. Identification shall be by means of adhesive labels.
2. Emergency Power: Cover shall be painted red; cover shall indicate voltage with "EM" added (i.e. 120EM) using ½" text; source(s) and circuit(s) contained within using ½" text. Identification shall be by means of adhesive labels.

B. Junction boxes for communications, signal and control systems: Identify system source and equipment serviced, labeled with ½" text in black on cover or engraved nameplates as follows:

1. Voice/Data Communications – V/D
2. Building Public Address System – PA

3. Closed Circuit TV – CCTV
4. Security System – SEC
5. Cable or Antenna TV – MATV
6. Intercom – IC

C. Junction boxes for Fire Alarm System: Junction box covers shall be painted red with “FA” labeled with 1” text in black on cover.

## 3.5 CONDUCTOR IDENTIFICATION

A. Install label tags on conductors in junction boxes, pull boxes, wireways, pole handholes and wiring gutters of panels.

B. Line voltage conductors shall be identified by panel and circuit number using sleeve type adhesive markers.

C. Each phase conductor of each feeder shall be identified at both ends and at all accessible locations with colored plastic tape, as well as typed identification labeling. Each phase shall be identified by a different color per industry standards. Painted identification is not acceptable.

D. Where wires of different system junction in a common box each cable shall be grouped with its own system and identified using tags or identification strips.

## 3.6 BRANCH CIRCUIT IDENTIFICATION

A. Each distribution and lighting panel shall be equipped with a typewritten directory describing the loads served. Directory **shall be** contained in a steel frame mounted on the inside face of the panel’s door and shall be covered with a sheet of clear plastic.

B. Circuit descriptions shall be complete and include device/equipment type and relative location.

C. Minimum font size shall be 10pt.

## 3.7 LIGHTING RELAY CONTROL PANEL IDENTIFICATION

A. Each lighting relay panel shall be equipped with a typewritten directory describing the loads served. Directory shall be contained in a steel frame mounted on the inside face of the panel’s door and shall be covered with a sheet of clear plastic or inserted inside a appropriately sized plastic pouch if no manufacturer frame is provided.

B. Relay descriptions shall be complete and include circuit controlled, device/equipment type controlled and relative location.

C. Minimum font size shall be 10pt.

## 3.7 WIRING DEVICE IDENTIFICATION

A. Each receptacle and light switch lighting faceplate shall indicate circuit (source and circuit number) using 1/4” text. Identification shall be by means of adhesive labels located on bottom of faceplate.

END OF SECTION

## SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATON STUDY

## PART 1 – GENERAL

### 1.1 SECTION INCLUDES

A. Protective Device Coordination Study and required adjustments.

### 1.2 REFERENCES

A. The studies shall be performed in strict accordance with the latest revision of the following standards:

1. ANSI/IEEE Std. 141-1986 IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.
2. ANSI/IEEE Std. 242-1986 IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
3. ANSI/IEEE Std. 602-1986 IEEE Recommended Practice for Electric System in Health Care Facilities.
4. ANSI C57.12.59 Guide for Dry-Type Transformer Through-Fault-Current Duration.
5. ANSI C57.109 Guide for Transformer Through-Fault-Current Duration.
6. Insulated Cable Engineers Association Standards.
7. National Electrical Code, ANSI/NFPA 70.
8. OSHA.

### 1.3 DESCRIPTION OF WORK

A. The electrical system protective device coordination study shall include all new electrical distribution equipment installed as part of this project and existing devices related to achieve selective coordination.

B. Collect field data as required. This shall include gathering information on existing circuit breakers, new motors, length and clarification of new feeders and new device characteristics.

C. Perform a digital-computer-based study using the latest ANSI/IEEE Standards calculation methods; perform a protective device coordination study for the system.

1. The coordination study shall include computer-drawn coordination curves which illustrate proper relay/breaker settings and fuse size selection to obtain proper coordination and protection of the equipment. The coordination curves shall be drawn on Keuffel and Esser log-log paper #48-5258 or approved computer equivalent.
2. The plots (no larger than 11” x 17”) shall include complete titles, a simplified single-line diagram for the portion of the system being coordinated, significant motor starting characteristics, complete parameters of transformers, minimum melt and total clearing characteristics of fuses, and complete operating bands of low voltage circuit breaker trip curves. The coordination plots shall indicate the type of protective devices selected, proposed relay taps, time dial and instantaneous settings, transformer magnetizing inrush and ANSI withstand curves, cable thermal overcurrent withstand limits, and significant symmetrical and asymmetrical fault currents. A maximum of eight (8) devices shall be shown on any sheet.

3. All restrictions of the NEC shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained.
4. Separate coordination plots shall be provided for phase devices and ground-fault devices.
5. The coordination study shall include protective device setting records for each substation, switchgear lineup, switchboard, panelboard, etc. A report shall be provided to summarize the results of the protective device coordination study. The report shall include relay and circuit breaker setting sheets and coordination curves. Recommendations shall be provided including but not limited to missing devices, misapplied devices, NEC violations, or devices that are not providing satisfactory protection and/or coordination.

E. As part of the studies, a listing of recommended relays, circuit breakers, fuses, etc. including complete ordering information, shall be provided in a timely fashion.

## 1.4 QUALIFICATIONS

A. The Contractor shall have the studies performed by qualified engineers of the switchgear manufacturer or by an Owner-approved consultant. The Contractor is responsible for providing all pertinent information required by the preparer of the study.

B. The study shall be performed by an engineer registered in the state where the project is located.

C. The final study shall be sealed and signed by the study engineer.

D. The equipment manufacturer or consulting engineer shall specialize in perform short circuit and protection devices studies and shall have a minimum of three years experience.

## 1.5 SUBMITTALS

A. Submit the study under provisions of Section 26 05 00 and Division 1.

B. Within two (2) weeks of award of the Contract, submit resume of the Study Engineer's qualifications.

C. The studies shall be accomplished so that circuit breaker and/or relay specification recommendations are submitted prior to or at the same time as the distribution equipment shop drawings so that the correct relays or circuit breaker options are ordered in a timely manner at no added cost to the Owner.

D. Submit the final report in the quantity dictated by the Architect/Engineer. The final report shall include the following:

1. Description, purpose, basis and scope of the study and a single-line diagram of that portion of the power system which is included within the scope of the study.
2. Tabulations of circuit breakers, fuse and other protective device ratings versus calculated short circuit duties and commentary on same.
3. Fault current calculations including a definition of terms and guide for interpretation of computer print-out.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selections and commentary on same.

## PART 2 – PRODUCTS

Not Used.

## PART 3 – EXECUTION

### 3.1 GENERAL

A. Implementation of settings and/or study recommendations shall be included in bid to provide a coordinated emergency system.

B. The Contractor shall hire an independent testing contractor to perform protective device calibration and apply prescribed settings. This Contractor shall assist testing contractor by providing work force and materials as required.

END OF SECTION

## SECTION 26 22 00 - LOW VOLTAGE TRANSFORMERS

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable requirements of Division 1 shall govern work in this section.

### 1.2 SCOPE

A. Provide auxiliary transformers of the kva rating and voltage characteristics as indicated on the drawings and as specified herein.

### 1.3 RELATED WORK

A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 05 26 – Grounding and Bonding for Electrical Systems

C. Section 26 05 29 – Hangers and Supports for Electrical Systems

D. Section 26 05 33 – Raceway and Boxes for Electrical Systems

E. Section 26 05 53 – Identification for Electrical Systems

### 1.4 QUALITY ASSURANCE

A. Equipment shall conform to the requirements of the following agencies:

1. National Fire Protection Association (NFPA) – 70, National Electrical Code (NEC) and Wisconsin Amendments thereto.
2. Underwriters Laboratories, Inc. (UL)
3. Local Codes and Ordinances.
4. National Electrical Manufacturers Association (NEMA)
5. American National Standards Institute (ANSI)
6. National Electrical Contractors Association (NECA)
7. Transformers shall be subject to the following production tests:

    a. Applied potential.
    b. Induced potential.
    c. No load losses.
    d. Voltage ratio.
    e. Polarity.
    f. Continuity.

### 1.5 SUBMITTALS

A. Shop drawings shall be in accordance with Section 26 05 00. Shop drawings shall include:

1. Manufacturer's nameplate data and electrical ratings.
2. Dimensioned drawings of transformers and accessories.
3. Submit operating and maintenance data.
4. Submit field quality control test and adjustment data.

## PART 2 – PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. General Electric Co.

B. Square D Co.

C. Cutler-Hammer

### 2.2 MATERIALS AND EQUIPMENT

A. Transformers shall be dry type, air cooled, NEMA TP1.

B. Insulation shall be Class H or better, having a 150 deg. C. rise, average maximum over 40 deg. C. temperature ambient.

C. Transformers shall be ”K” rated if and as indicated on the plans.

D. Cores shall be high grade, non-aging, sheet silicon steel laminations having core plating insulation on both sides of each lamination.

E. Coils shall be continuous wound, impregnated with non-hygroscopic varnish, and the coil/core shall be bolted to bottom of enclosure.

1. No metal-to-metal contact shall occur between coil/core and enclosure. Coil/core and enclosure shall be isolated by rubber, vibration absorbing mounts.

F. Transformer shall contain four taps. Two 2 ½% taps above and two 2 ½% taps below.

G. Sizes as indicated on drawings and schedules.

H. Transformers shall be quiet type for installation in areas of low ambient noise levels. Maximum sound levels shall not exceed NEMA standards.

I. Cabinets shall be sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.

J. Wall mounting brackets through 75 kva (where required on plans).

K. Nameplate shall be a metal nameplate listing manufacturer’s name, serial number, type, class kva voltage, frequency and showing internal wiring diagram.

L. Following requirements shall be in accordance with Underwriter’s Laboratories specification UL506:

1. Ventilation openings.
2. Corrosion resistance.
3. Cable bending space.
4. Grounding provisions.
5. Surface temperature.
6. Winding compartment temperature rise.
7. Terminations.

## PART 3 – EXECUTION

### 3.1 INSPECTION

A. Examine areas and conditions under which transformers are to be installed and notify Engineer, in writing, of conditions detrimental to proper and timely completion of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF TRANSFORMERS

A. Install in accordance with manufacturer's written instructions and in accordance with recognized industry practices. Support from floor, wall or ceiling as appropriate to layout and space needs.

B. Install wall mounted transformers on prefabricated brackets designed for purpose.

C. Install floor mounted transformers on 4 inc. concrete housekeeping pad.

D. Tighten bus connections and mechanical fasteners.

E. Install fuses or breakers as shown on drawings.

F. Adjust voltage taps for required system voltage and check grounding requirements.

G. Touch up scratched or marred surfaces to match original finish.

### 3.3 FIELD QUALITY CONTROL

A. Test and permanently record the following:

1. Prior to energization of transformers, check phase-to-phase and phase-to-ground insulation resistance levels.
2. Check transformers for continuity of circuits and for short circuits.
3. Subsequent to wire and cable hook-ups, energize transformers and demonstrate functioning.

### 3.4 FIELD QUALITY CONTROL

A. Handle carefully to prevent internal component damage, breakage and denting and scoring the enclosure finish. Do not install damaged transformers.

B. Store transformers in a clean dry space. Protect from dirt, fumes, water, construction debris, physical damage.

END OF SECTION

## SECTION 26 24 16 - PANELBOARDS

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide panelboards as indicated in the panel schedule, as noted on the drawings and as specified herein.

### 1.3 RELATED WORK

A. Section 26 05 00 – Common Work Results for Electrical

B. Section 26 05 53 – Identification for Electrical Systems

C. Plans - Panel Schedules

### 1.4 SUBMITTALS

A. Shop Drawings

1. Cabinet dimensions, nameplate nomenclature, electrical ratings and breaker type listing.
2. Product data sheets with installation instructions.
3. Field quality control test results.
4. Operating and maintenance data.

### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Do not store panelboards exposed to weather.

B. Protect panelboards against damage from work of other trades.

## PART 2 – PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURES

A. Use of a manufacturer's name and model or catalog number is for the purpose of establishing standard of quality and general configuration desired.

B. Square D

C. Bussmann (Fusible Panelboards)

### 2.2 PANELBOARD RATINGS

A. UL listed short circuit rating (integral equipment rating):
1. 208Y/120V Lighting Panels: 10,000 RMS symmetrical amperes minimum or higher as specified on the drawings. Equivalent to Square D type NQ.

Panelboards with AIC ratings of 22,000 RMS symmetrical amperes or lower shall be fully rated.

2. 480Y/277V Lighting Panels: 18,000 RMS symmetrical amperes minimum or higher as specified on the drawings. Equivalent to Square D type NF. Panelboards with AIC ratings of 35,000 RMS symmetrical amperes or lower shall be fully rated.
3. Power Panels: 25,000 RMS symmetrical amperes minimum or higher as specified on the drawings. Equivalent to Square D I-Line. Panelboards shall be fully rated.

## 2.3 PANEL CONSTRUCTION

A. Main breaker or main lugs only, per panelboard schedule.

## 2.4 BUSSING

A. Plated copper phase bussing.

B. Plated copper neutral bus with terminals.

C. Copper equipment grounding bus with terminals.

D. Distributed phase sequence type.

E. Ratings per panelboard schedule, 100 amp minimum.

## 2.5 PANEL CABINETS

A. Code gauge galvanized steel.

B. Minimum 20” wide.

C. Minimum 5¾ “ deep.

D. Height as required to accommodate breakers and spaces indicated on plans and code required gutter space.

E. Gutters adequate for wire size used, 4 inches minimum.

## 2.6 PANEL FRONTS

A. Dead front safety type.

B. Concealed adjustable trim clamps.

C. Code gauge steel with rust inhibiting primer and baked enamel finish.

D. Panel front cover shall have piano hinge to allow access to wiring gutters without removal of panel trim. Hinged trim held in place with screw fasteners. Door shall be built into trim which allows access to breakers as well as to hinged trim screw fasteners. Breakers access door shall have the following features:

1. Concealed piano hinge.
2. Flush stainless steel cylinder tumbler type locks with spring loaded door pulls.
3. Locks for all job panels keyed alike.

E. Steel frame circuit directory holder with directory cards on inside face.

1. Suitable for complete descriptions.
2. Clear plastic cover.
3. Typewritten descriptions.

## 2.7 BRANCH BREAKER DETAILS

A. Thermal Magnetic type.

B. UL Class A ground fault circuit protection (GFI) as indicated on drawings.

C. UL listed terminals for type and temperature rating of wire utilized. Anti-turn solderless type.

D. Circuit breaker construction for NQOD and NF panels shall bolt on to panel bussing.

E. Circuit breaker construction for I-Line panels shall plug on to panel bussing but breaker cases shall bolt to panel cabinet.

## 2.8 FUSIBLE PANELBOARDS

A. Fusible Branch Circuit Panelboards shall be Cooper Bussmann® Quik-Spec™ Coordination Panelboards type QSCP.

B. Panelboard shall be equipped with a six-space spare fuse holder for storing replacement branch circuit fuses. Spare fuse holder shall be located behind locking panel door. Provide a combination of six spare fuses similar to complement of fuses installed in panelboard.

C. Provide main lugs only, fused main disconnect or non-fused main disconnect as indicated on the plans. Main disconnect switches shall be lockable.

D. BRANCH FUSED DISCONNECTS

1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
2. Device shall provide open fuse indication via permanently installed neon indicating light.
3. Device shall be UL and cUL Listed 600Vac, 200kA short-circuit current rating, load-break disconnect with amperage ratings and number of poles as indicated on the panelboard schedule.
4. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
5. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
6. No special tools shall be required for fuse removal.
7. Devices shall have bolt-on style bus connectors.
8. Device housing shall be clearly marked with device amperage.
9. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
10. Device shall provide fuse ampere rating rejection to ensure continued circuit protection at the specified circuit rating.

11. Branch circuits shall be Bussmann Compact Circuit Protector Base (CCPB) with Cubefuse.

## PART 3 – EXECUTION

### 3.1 INSPECTION

A. Examine area to receive panelboard to assure adequate clearance for panelboard installation.

B. Start work only after unsatisfactory conditions are corrected.

### 3.2 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices.

B. Flush mount or surface mount as specified on drawings and schedules.

C. Support panel cabinets independently to structure with no weight bearing on conduits.

D. Install recessed panelboards to allow cover to be drawn tight against wall to provide neat appearance.

E. Install panelboards so top breaker is not higher than 6 ft-0 in. above floor.

F. Adjacent panel cabinets shall be of same size and mounted in horizontal alignment.

G. Install in each panelboard a typewritten directory accurately indication rooms and/or equipment being served.

H. Attach nameplates. Nameplates for panels in public areas shall be attached to the inside face of the cover. Nameplates for panels in equipment rooms and other nonpublic areas shall be attached to the outside face of the cover.

**I. Recessed panelboards shall include four (4) spare 1" conduits from panel up to above ceiling on floor of panel AND down to above ceiling of floor below (if a building level exists below).**

### 3.3 FIELD QUALITY CONTROL

A. Balanced load among feeder conductors.

B. Unbalance shall not exceed ± 7½ % of computed average load per phase.

C. Energize each circuit and check for complete and correct function.

D. The contractor shall verify that selective coordination is achieved on the emergency system between the fusible panelboard and upstream protective devices, making adjustments to devices as appropriate.

## 3.4 ADJUSTMENT AND CLEANING

A. Adjust doors and operating mechanisms for free mechanical movement.

B. Tighten lugs and bus connections.

C. Sand, prime and paint scratched or marred surfaces to match original finish.

END OF SECTION

## SECTION 26 27 02 - EQUIPMENT WIRING SYSTEMS

### PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide connections and wiring to motors as indicated in the motor wiring and special purpose outlets schedules, as indicated on the drawings and also as indicated in other divisions of the specifications and as specified herein.

### 1.3 RELATED WORK

A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 27 28 – Disconnect Switches

C. Section 26 29 00 – Low-Voltage Controllers

### PART 2 – PRODUCTS

Not Used.

### PART 3 – EXECUTION

### 3.1 GENERAL

A. Motor starters and/or disconnect switches shall be furnished and installed by the responsible contractor as indicated in the motor wiring schedule.

B. This Contractor shall check the drawings and specifications of the other trades to determine the requirements for motor disconnect switches. In each case, the Contractor shall install all required disconnect switches. The Electrical Contractor shall also provide all code required disconnect switches not specifically supplied by others.

C. Unless otherwise indicted on the drawings or elsewhere in these specifications, all motors shall be furnished by others.

D. Motors shall be set in place by others and the associated motor starters and controllers shall be turned over to the Electrical Contractor for installation.

E. Any contractor supplying starters and controllers shall index same and provide the Electrical Contractor with written instructions as to proper location in sufficient time to permit the installation of a concealed raceway system.

F. Control wiring, regardless of voltage, shall be the responsibility of the Contractor providing the motor. The Electrical Contractor shall extend the 120 volt circuit to the control transformers and make final 120V transformer connections. Transformers will be supplied by HVAC Contractor. Location of control transformers shall be in close proximity of the heating equipment.

G. Review the HVAC and plumbing specifications and provide all line voltage wiring and connections to controls and auxiliary equipment specified as to be provided by the Electrical Contractor.

## 3.2 INSPECTION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

## 3.3 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.

## 3.4 INSTALLATION

A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit in damp or wet locations.

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. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.

F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.

## 3.5 HVAC AND PLUMBING CONNECTIONS

A. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters, variable frequency drives (VFDs), and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.

B. VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.

C. Provide 120 volts to each control panel.

D. Unless otherwise specified, all electrical motors and control devices such as aquastats, float and pressure switches, fan powered VAV boxes, switches, electro-pneumatic switches, solenoid valves and damper motors requiring mechanical connections shall be furnished and installed and wired by the Contractor supplying the devices.

E. Each motor terminal box shall be connected with a minimum 12", maximum 36" piece of flexible conduit to a fixed junction box. Use liquidtight flexible metal conduit for connections in damp or wet locations. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.

F. Check for proper rotation of each motor.

### 3.6 ELEVATOR CONNECTIONS

A. Coordinate required connections as indicated on the plans.

END OF SECTION

## SECTION 26 27 26 - WIRING DEVICES

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide wiring devices generally consisting of switches, receptacles and occupancy sensors as indicated on the drawings and as specified herein.

### 1.3 RELATED WORK

A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 05 33 – Raceway and Boxes for Electrical Systems

### 1.4 SHOP DRAWING SUBMITTALS

A. Listing of brand names and types of materials proposed for use.

B. Nameplate nomenclature.

C. Electrical ratings.

## PART 2 – PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. Use of a manufacturer's name and model or catalog number is for purpose of establishing standard of quality and general configuration desired only.

B. Cooper

C. Hubbell Wiring Device Div.

D. Pass and Seymour, Inc.

E. Leviton

F. LVS, Inc.

G. WattStopper is the only approved manufacturer for occupancy sensors.

### 2.2 GENERAL

A. Provide factory-fabricated, NEMA specification grade wiring devices in type, color and electrical rating for service indicated.

B. Provide wiring devices of one manufacturer.

C. See Symbol Schedule on drawings for identification of device type.

D. Wiring devices for use with stranded conductor shall have a clamping type terminal that can be physically tightened. The clamping device shall not be a spring type of clamp.

## 2.3 SWITCHES

A. General use lighting switches: 20 amp toggle type. Pass and Seymour CS20AC1 Series.

B. Dual level lighting switches (identified as “DLS” or “SD”): 15 amp, two switches in single yoke, specification grade. Pass and Seymour 670 (toggle) series.

C. Switches with pilot lights (identified as “PL”). Each switch shall be complete with engraved plate to identify equipment being controlled (White letters on black, 1/8 inch high minimum). Pass and Seymour PS20AC1CPL.

D. Dimmer switches shall be equal to Lutron Ariadni series rated for respective controlled load.

E. Switch color shall be as selected by the architect; multiple colors may be required. Switch color shall be red where it controls an emergency circuit.

## 2.4 RECEPTACLES

A. General use duplex receptacles: NEMA type 5-15R, grounding type, 15 amp, 120 volt rating, impact resistant face and body, side wired, commercial specification grade rated.

B. Where a single duplex receptacle is wired to a dedicated 20 ampere, 120 volt circuit, provide NEMA type 5-20R grounding type 20 ampere receptacles, impact resistant face and body, side wired, commercial specification grade rated.

C. Special purpose receptacles: As shown on drawings and schedules.

D. Ground fault circuit interrupter duplex receptacles: Test and reset buttons shall match device color, LED trip indicator. Device shall meet UL 2003 requirements. Provide weather resistant type for outdoor locations.

E. Isolated ground type duplex receptacle. NEMA type 5-20R, grounding type, 20 amp, 120 volt rating, commercial specification grade.

F. Transient voltage surge suppression receptacles shall comply with UL 1449 for both category “A” and “B”, and with ANSI/IEEE C62.41. Device shall suppress transients in 3 modes. Device shall contain a led indicator to indicate failure of protective circuitry. Three mov’s will each be rated 500 volts and 210 joules. Commercial specification grade.

G. Receptacle color shall be as selected by the architect; multiple colors may be required. Receptacle color shall be red where served from an emergency circuit.

H. Receptacles to be standard type, except in hotel rooms, apartments and condos to be decorator type.

## 2.5 WIRING DEVICE PLATES AND COVERS

A. Provide wall plates for wiring devices with ganging and cutouts as indicated and with metal screws for securing plates to devices, screw heads colored to match finish of plate.

B. Plates for flush mounted devices: Coverplates shall be smooth, hi-impact nylon material. Color of plates and screws shall match device.

C. Device plates for kitchen areas: Stainless steel 302/304 with stainless steel screws.

D. Device plates for surface mounted Type FS or FD boxes: Type FSK galvanized steel covers.

E. Device plates for surface mounted, 4 inch square boxes in mechanical, janitorial, electrical spaces: ½“ raised, galvanized steel covers.

F. Device plates and covers for exterior duplex receptacles shall be weatherproof-while-in-use type with lockable, cast aluminum cover (plastic covers not allowed). Use proper cover to match orientation of installed device.

## 2.6 OCCUPANCY AND LIGHT SENSORS

A. Provide occupancy and light sensors for the automatic control of room lighting as indicated on the drawings and as specified herein. The Contractor is to adjust the sensitivity to provide optimal operation.

B. All low voltage wiring for this system may be installed exposed above accessible ceilings or in wall cavities. All cable installed in return plenum areas shall be rated for such use. Exposed cable shall be supported every 5 feet minimum via bridal clamps or tie wraps.

C. Wall mounted (W) sensors: Watt Stopper #WS-250.

D. Wall mounted sensors with dual level switching capabilities (W, DLS) or controlling two independent loads (W,2): Watt Stopper #PW-200.

E. Ceiling mounted ultrasonic (UA or UH) sensors: Watt Stopper true 360 degree Area types #W1000A or #W2000A or Hall type #W2000H with power pack as required. Provide appropriate type sensor based on area covered.

F. Ceiling mounted dual technology (DT) sensors: Watt Stopper #DT-200 with power pack as required. Locate as close to corner of room as possible while maintain appropriate room coverage,

G. Wall mounted timer switches (TS) in Mechanical and Electrical Rooms shall be Watt Stopper #TS-400.

H. Standalone Light (LS) Sensors: Watt Stopper #LS-100XB with power pack as required.

I. Card Key (CK) switches: Watt Stopper #HS-100 series with power pack(s) as required.

J. Wall mounted occupancy sensor color shall match wiring device color in respective area as selected by the architect; multiple colors may be required.

## 2.7 EMERGENCY TRANSFER RELAYS

A. Provide UL924 listed emergency power transfer relay with 20A NC relay rating, LEDs for normal and emergency source availability and test switch. The relay shall be installed flush in finished ceiling areas or surface mounted (ceiling in unfinished public areas or wall in elec/mech/storage rooms) in accordance with manufacturer requirements.

B. The relay shall be manufactured by LVS, Inc.
   1. Typical relay: Model EPC (120V or 277V).
   2. Step-Dim ballast Relay (2 ballasts max.): Model EPC-PM-A (120V or 277V)
   3. Dual-level relay (2-ballasts): Model EPC (120V or 277V).
   4. 2 & 3-wire dimmable load transfer relay: Model EPC-D-F (120V or 277V).

# PART 3 – EXECUTION

## 3.1 INSPECTION

A. Examine areas and conditions under which wiring devices are to be installed and notify Engineer, in writing, of conditions detrimental to proper and timely completion of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices.

B. Do not install devices until wiring is complete.

C. Before installing receptacles and switches, clean electrical boxes of dirt and debris.

D. Do not use terminals on wiring devices (hot or neutral) for feed-through connections, looped or otherwise. Make circuit connections via wire connectors and pigtails.

E. Install gasket plates for devices or system components having light emitting features, such as switches with pilot lights. Where installed on rough textured surfaces, seal plates with black self-adhesive poly-foam.

F. Ground receptacles with an insulated green ground wire from device ground screw to a bolted outlet box connection. Route a continuous green equipment grounding conductor with branch circuit conductors serving isolated ground receptacles. Terminate the equipment ground on the ground bus in panelboards.

G. Install emergency switches which occur adjacent to normal light switches in separate boxes to maintain systems isolation in accordance with the NEC. Provide red wiring devices and coverplates for devices wired to emergency power circuits.

H. All 15 and 20A, single-phase, 125V, receptacles to serve countertops installed in kitchens, shall be GFI type and/or protected.

I. Stranded conductor terminating on wiring devices shall be terminated in a clamping terminal and not on the screw terminal.

J. Provide a layer of electrical tape around the perimeter sides of each wiring device so that the terminations are insulated.

K. Gang switches together when located at the same location.

L. Mount emergency relays in accessible location (i.e. mechanical room or flush with wall/ceiling). Provide a typed label indicating “EMERGENCY LIGHTING RELAY FOR _____” – insert appropriate controlled load).

## 3.3 FIELD QUALITY CONTROL

A. Provide operational testing for all devices.

B. Test receptacles with Hubbell 5200, Woodhead 1750 or equal, for correct polarity, proper ground connection and wiring faults.

C. The manufacturer’s representative shall verify that the specified occupancy sensors are appropriate and located correctly for their application and/or room size.

D. Occupancy Sensor Sensitivity Test: After the sensor has been energized for at least 15 minutes, walk to the middle of the room or sit at the normal desk position. Make no motion for 20 seconds. Move one arm up and down slowly. The test LED should blink. Check all positions within a room to confirm that there are no dead areas.

E. Occupancy Sensor Time Delay Test: Set the time delay for 10 minutes. Walk into the room to activate the sensor then leave room. Sensor must turn lights off at approximately 10 minutes. Walk into the room again to reactivate the lights. Lights should activate within 1 second.

END OF SECTION

## SECTION 26 27 28 - DISCONNECT SWITCHES

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide disconnect switches for the safe disconnection of motorized equipment and other equipment as required by the national and state electrical codes and as specified herein.

### 1.3 RELATED WORK

A. Section 26 05 53 – Identification for Electrical Systems

B. Section 26 05 26 – Grounding and Bonding for Electrical Systems

C. Section 26 27 02 – Equipment Wiring Systems

### 1.4 SHOP DRAWING SUBMITTALS

A. Enclosure dimensions, nameplate nomenclature, electrical ratings, fuse and breaker type listing.

B. Field quality control test results.

## PART 2 – PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. General Electric

B. Square D

C. Cutler-Hammer

### 2.2 DISCONNECT RATINGS

A. UL listed short circuit rating:

1. 200,000 RMS amps with Class R fuses.

### 2.3 SAFETY SWITCH CONSTRUCTION

A. NEMA heavy duty Type HD.

B. Dual cover interlock.

C. Visible blades.

D. Provisions for control circuit interlock.

E. Pin type hinges.

F. Tin plated copper current carrying parts.

G. Quick make and break operator mechanism.

H. Handle attached to box, not cover.

I. Handle position indication, ON in up position and OFF in down position.

J. Padlock provisions for up to three padlocks in OFF position.

K. UL listed lugs for type and size of wire specified.

L. Spring reinforced fuse clips for Type R fuses.

M. Provisions for insulated or grounded neutral.

## 2.4 ENCLOSURES

A. Indoor: NEMA 1 code gauge steel with rust inhibiting primer and baked enamel finish.

B. Outdoor: NEMA 3R code gauge zinc coated steel with baked enamel finish or NEMA 4 when indicated on drawings.

C. Corrosive Area: NEMA 4X Type 304 stainless steel with brushed finish.

D. Hazardous Area: NEMA 7/9 cast, copper free, aluminum alloy.

# PART 3 – EXECUTION

## 3.1 GENERAL

A. Provide disconnect switches for loads as required by code. Review HVAC and Plumbing specifications to determine what equipment is furnished with disconnect switches. Install all disconnect switches whether furnished under this contract or not. It is the Electrical Contractors responsibility to determine the need for disconnect switch requirements for each specific load. The contractors shall include in their bid all disconnect switches required whether indicated on the drawings or not.

## 3.2 INSPECTION

A. Examine area to receive disconnect to assure adequate clearance for installation.

B. Start work only after unsatisfactory conditions are corrected.

## 3.3 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices.

B. Locate disconnect switches as shown on drawings or as required by NEC.

C. Install on equipment support where feasible or anchor firmly to wall or structural surface.

D. Provide control circuit interlock as required by NEC.

## 3.4 ADJUSTMENT

A. Adjust covers and operating mechanism for free mechanical movement.

B. Verify overcurrent protection to provide proper operation and compliance with NEC.

C. Tighten wire and cable connections.

D. Clean interior of enclosure.

E. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

## SECTION 26 28 13 - FUSES

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. The work under this section includes 250 and 600 volt fuses.

### 1.3 RELATED WORK

A. Section 26 27 28 – Disconnect Switches

B. Section 26 29 00 – Low-Voltage Controllers

### 1.4 SHOP DRAWING SUBMITTALS

A. Provide device dimensions, nameplate nomenclature, and electrical ratings.

B. Submit manufacturer's product data sheets with installation instructions.

### 1.5 REGULATORY REQUIREMENTS

A. Listed by Underwriter's Laboratories, Inc., and suitable for specific application.

### 1.6 EXTRA MATERIALS

A. Provide three (3) spares of each size and type fuse.

## PART 2 – PRODUCTS

### 2.1 250 VOLT FUSES

A. Fuses 600 Amperes and Less: Dual element, time delay, 250 volt, UL Class J. Interrupting Rating: 200,000 rms amperes.

### 2.2 600 VOLT FUSES

A. Fuses 600 Amperes and Less: Dual element, time delay, 600 volt, UL Class J. Interrupting Rating: 200,000 rms amperes.

**2.3** Fuses 601 Amperes and Larger: Time delay, 600 volt, UL Class L. Interrupting Rating: 200,000 rms amperes.

**2.4** Provide enclosure for spare fuses.

## PART 3 – EXECUTION

### 3.1 GENERAL

A. Fuses shall not be installed until equipment is ready to be energized.

B. Install spare fuse storage enclosure in Electrical Room.

END OF SECTION

## SECTION 26 29 00 - LOW-VOLTAGE CONTROLLERS

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide and install motor starters of the types as indicated on the drawings and as specified herein.

### 1.3 RELATED WORK

A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 05 53 – Identification for Electrical Systems

C. Section 26 05 04 – Cleaning, Inspection and Testing Electrical Equipment

D. Motor Wiring Schedule and control diagrams on the drawings.

### 1.4 SUBMITTALS

A. Shop Drawings

1. Showing enclosure dimensions, nameplate nomenclature, electrical ratings and thermal unit schedule.
2. Product data sheets with installation instructions.
3. Wiring diagrams and schematics.
4. Identify with tag number for proposed use.

B. Operating and Maintenance Data.

1. Manufacturer's printed instructions for replacing parts, performing cleaning and operating and maintaining motor starters.
2. Repair parts lists.
3. Field quality control test results.

### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Do not store motor starters exposed to weather.

B. Protect motor starters against damage from work of other trades.

## PART 2 – PRODUCTS

### 2.1 GENERAL

A. Use of a manufacturer's name and model or catalog number is for purpose of establishing standard of quality and general configuration desired only.

B. Starters shall be by one manufacturer.

## 2.2 ACCEPTABLE MANFACTURERS

A. Allen/Bradley.

B. Cutler-Hammer.

C. Square D.

D. General Electric.

## 2.3 MANUAL MOTOR STARTER CONSTRUCTION

A. Quick-make and break toggle action.

B. Double-break silver alloy contacts.

C. One-piece bi-metallic or melting alloy type thermal overload units.

D. Starter inoperative, unless thermal unit is in position.

E. Provision for padlocking in the “off” position.

F. Green pilot light to indicate when motor is running.

G. NEMA standards for size and horsepower rating.

H. Provisions for resetting starter after overloads trip the starter.

## 2.4 MAGNETIC MOTOR STARTER CONSTRUCTION

A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower; size 0 minimum.

B. Full Voltage Starting: Non-reversing type.

C. Reduced Voltage Starting: Solid-state type (soft start/soft stop) with bypass contactor, 1 – 25 sec. ramp equal to Square D ATS01 series.

D. Size: NEMA ICS 2; size as shown on Drawings, size 0 minimum.

E. Coil Operating Voltage: 120 volts, 60 Hz.

F. Overload Protection: bimetal or melting alloy.

G. Provide manufacturer’s equipment ground kit in all starter enclosures.

H. Auxiliary Contacts: NEMA ICS 2; two field convertible contacts in addition to seal-in contact.

I. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.

J. Indicating Lights: NEMA ICS 2; LED Push-to-test type. RUNNING (ON): green in front cover.

J. Relays: NEMA ICS 2; Provide on-time delay (0-60 sec) relays as indicated on the Drawings. Required for motors (10 HP and larger) connected to emergency generators.

M. Control Power Transformers: Each magnetic starter shall have a fused primary and a fused 120Vsecondary control transformer, sized for the load, 100 VA minimum. Additionally, the X2 terminal of the control transformer shall be grounded.

N. Combination Motor Starters: Combine motor starters with non-fusible switch disconnect in common enclosure.

## 2.5 VARIABLE FREQUENCY DRIVES

A. Standard Protection Features:
1. Phase-loss protection.
2. Instantaneous overcurrent.
3. Input line under-voltage trip.
4. Over-temperature.
5. Overcurrent.
6. Continuous ground fault.
7. Short circuit protection.
8. Motor overload protection.
9. Fuses: Bussmann, Low-Peak.

B. Basic Description:
1. The VFD controllers shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz. despite incoming voltage variations.
2. The VFD controllers shall be supplied with an integral input AC line reactor of minimum 2.5% impedance. Line reactor shall be designed to address performance issues of NEMA MG1-20.55 and to provide proper transient protection of the VFD input power devices.
3. The VFD controllers shall have a continuous output current rating of 100% of motor nameplate current up to 122 degrees F.
4. The VFD controllers shall be of the Pulse-Width Modulated type and shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor which generates a sine-code output voltage.
5. The inverter output shall be generated by power transistors which shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

C. The VFD controllers shall incorporate the following:
1. Adjustable to provide soft starting and stopping of the motor.
2. Linear acceleration and deceleration rates independently adjustable from 2 to 360 seconds.
3. Circuitry to initiate an orderly shutdown of the VFD controller for protection against:

a. Single phase fault or 3-phase short circuit on VFD output terminals without damage to any power component.
b. Static instantaneous overcurrent and overvoltage trip with inverse overcurrent protection.
c. Static over-speed (over-frequency) protection.
d. Line or fuse loss and under-voltage protection.
e. Power unit over-temperature protection.
f. Electronic motor overload protection.
g. Responsive action to motor winding temperature detectors or thermostatic switches.
h. Isolated operator controls.
i. Input line fuses.
j. Be insensitive to incoming power phase sequence.
k. Have de-saturation circuit to drive inverter section transistor base current to zero in event of controller fault.
l. Have DC bus discharge circuit for protection of operator and service personnel with an indicator lamp.
m. Input line noise suppression with line reactor.
n. Individual transistor over-current protection.

D. Input line reactors integral to the VFD controllers shall be provided to reduce both voltage and current harmonic distortion introduction on the line supply to within IEEE-519 (most current Standards).

E. The following system configuring settings shall be provided, without exception, field adjustable through the HMI keypad/display unit or via the serial communication port only. The VFD display shall be mounted on the front of the enclosure.

F. Motor Nameplate Data: Motor frequency, number of poles, full load speed, motor volts, motor full load amps, motor KW, current min., and current max.

G. VFD Limits: Independent accel/decel rates, no load boost, Vmin, Vmax, V/Hz., full load boost, overload trip curve select (Inverse or Constant), Min/Max speed (frequency), auto reset for load or voltage trip select, slip compensation, catch-A Spinning-Load select, and Overload trip time set.

H. VFD Parameters: Voltage loop gain, voltage loop stability, and current loop stability.

I. Controller Adjustments: PID control enable/disable, setpoint select, proportional band select, reset time select, input signal scaling, input signal select (4-20 mA/0-5 Volts), auto start functions: on/off, Delay On/Off, Level Select On/Off, speed profile: entry, exit, point select, min, max speed select, inverse profile select (allows VFD speed to vary directly or inversely with input signal.)

J. The fault log record shall be accessible via a RS232C/RS422 serial link as well as line by line on the keypad display.

K. The VFD firmware shall allow for the keypads to be removed allowing programming of each VFD the same.

L. The drive is to be provided with isolated 4-20 mA DC output signals proportional to speed, current or voltage (select maximum of two signals) for remote monitoring of the VFD.

M. Cooling shall be provided by the manufacturer. The MCC enclosure shall include ventilation fans and filtered air entering the bottom and leaving the top of the enclosure.

N. Communication Card: Provide a BACNET communication card for each drive.

O. System Operation: With the manual start pushbutton selected, the drive shall be controlled by the increase/decrease pushbuttons on the drive keypad. The VFD manual speed shall be controlled by the keypad on the front panel.

P. The controllers shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:
   1. Power transistors, SCRs and diodes shall be tested to ensure correct function and highest reliability.
   2. Every controller shall be functionally tested with the motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

Q. VFD controller shall be U.L. listed. The VFD shall be compatible with the motor supplied and shall be rated for Horsepower, amperage and other requirements for complete compatibility.

R. The VFD controllers shall be provided with front panel mounted Hand-Off-Auto selector switches, HMI keypads, Green On" and Red "Failure" Push-To-Test LED transformer Type indicating lights and ETM's.

S. The controller shall be designed and constructed to operate within the following service conditions:
   1. Elevation: To 3300 Feet
   2. Ambient Temperature, Range: 0°C to 40°C
   3. Atmosphere: Non-Condensing relative humidity to 95%
   4. AC Line Voltage Variation: -5% to +10% AC Line,
   5. Frequency Variation: ±3 Hertz.

T. Combination Motor Starters: Combine motor starters with non-fusible switch disconnect in common enclosure.

## 2.6 CONTROLLER OVERCURRENT PROTECTION AND DISCONNECTING MEANS

A. Nonfusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

## 2.7 ENCLOSURES

A. Indoor
   1. Manual Starters: General purpose flush mounted in finished areas or NEMA 12 surface mounted in unfinished areas.
   2. Magnetic and VFD Starters: NEMA 12 surface mounted.

B. Outdoor
   1. NEMA 3R.

C. Code gauge steel with rust inhibiting primer and baked enamel finish.

## PART 3 – EXECUTION

### 3.1 INSPECTION

A. Examine area to receive motor starter to assure adequate clearance for motor starter installation.

B. Start work only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized practices.

B. Install on equipment rack, in MCC, or mounted firmly to wall of structural surface. Refer to plumbing plans or heating, ventilating and air conditioning plans for starter locations.

C. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

D. Select and install heater elements in motor starters to match installed motor characteristics to provide proper operation and compliance with NEC.

E. Install motor control centers on 4 in. concrete pad, secured with steel bolts.

### 3.3 FIELD QUALITY CONTROL

A. Megger check of phase-to-phase and phase-to-ground insulation levels.

B. Do not megger check solid state equipment.

C. Test for continuity between line and load terminals and between control terminals.

D. Short circuit.

E. Operational check.

F. Test each motor and permanently record following information:
   1. Motor identification as to the load served.
   2. Nameplate data.
   3. Overload relay equipment.
   4. Protective relay (if any) setting.
   5. Voltage and current phase readings.
   6. Direction of rotation.
   7. Furnish spare overloads in each size utilized and turn over to owner.
   8. Provide a spare control transformer for each starter size utilized and turn over to owner.

### 3.4 ADJUSTMENT AND CLEANING

A. Adjust covers and operating mechanisms for free mechanical movement.

B. Tighten wire and cable connections.

C. Verify over current protection thermal unit size with motor nameplate.

D. Clean interior of enclosure.

E. Touch up scratched or marred surfaces to match original finish.

## 3.5 VFD SYSTEM PROGRAMMING

A. The VFD manufacturer shall provide an on-site representative to program the VFD units to start, stop and operate per the control logic provided by the HVAC, fire protection and/or plumbing contractors as appropriate.

## 3.6 OWNER TRAINING

A. The Electrical Contractor and VFD commissioning technician shall provide a minimum of two (2) hours of training on the operation and programming of the VFD units.

## 3.7 TESTS

A. Measure insulation resistance of each starter section phase to phase and phase to ground with the starter contacts closed and the protective device open.

B. Measure insulation resistance of each control circuit with respect to ground.

C. Test motor overload units by injecting primary current through overload unit and monitoring trip time.

D. Perform operational test by initiating devices to effect proper operation.

END OF SECTION

## SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable requirements of Division 1 shall govern work in this section.

### 1.2 DESCRIPTION

A. Provide a factory assembled, metal enclosed, automatic transfer switch for distribution and control of power from normal power supply or from output of a standby engine/generator upon failure of normal power supply to outgoing feeder terminals and automatic retransfer back to normal power supply upon resumption of normal service.

B. Provide remote annunciators/controllers as required on the plans for the transfer switches and generators.

### 1.3 RELATED WORK

A. Section 26 05 04 – Cleaning, Inspection and Testing Electrical Equipment

B. Section 26 05 53 – Identification for Electrical Systems

C. Section 26 05 26 – Grounding and Bonding for Electrical Systems

### 1.4 QUALITY ASSURANCE

A. Equipment shall comply with the requirements of the following agencies:

1. U.S. Environmental Protection Agency (EPA):
   a. Design Criteria of Mechanical, Electrical and Fluid System and Component Reliability.
2. National Fire Protection Association (NFPA).
3. Underwriters Laboratories, Inc. (UL).
4. Local codes and ordinances.
5. American National Standards Institute (ANSI).
6. National Electrical Manufacturers Association (NEMA).
   a. Standard ICS.

B. Perform the following production tests on the completed transfer switch:

1. Operation of individual component.
2. Correct overall sequence of operation.
3. Transfer time.
4. Voltage.
5. Time delay settings.
6. Dielectric strength test per NEMA Standard ICS 1-109.05.

C. A prototype of the switch shall have been subjected to and have passed the following tests by a certified independent testing laboratory.

1. Overload and endurance at 480VAC per Table 21.2 and 23.2 of UL 1008 when enclosed per Table 1.6.

D. Provide with full rated neutral bar.

E. The switch shall have passed tests per paragraph 25 of UL 1008 to withstand current @ 480 VAC and X/R ratio of 6.6 or less using overcurrent device upstream of the ATS.

F. The entire transfer switch and relay plate assembly should be capable of withstanding a 2500 volt crest transient per IEEE Standard 472-1974. The transient voltage test shall be conducted across the normal source terminals, the emergency source terminals and between opposite normal and emergency source terminals. A certified laboratory test report from an independent testing laboratory shall be furnished to verify conformance.

## 1.5 SUBMITTALS

A. Shop drawings shall indicate transfer switch, control panel and enclosure dimensions, control arrangements, and single-line diagrams in accordance with ANSI Y 32.2 indicating connections and controls.

B. Submit manufacturer's written recommendations for storage and protection, installation instructions and field test requirements.

C. Submit manufacturer's instructions for start-up, performing cleaning, operating and maintaining transfer switch systems.

# PART 2 – PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURER

A. Russelectric, Inc.

## 2.2 TRANSFER SWITCH RATINGS

A. Rating shall be as indicated on the plans.

B. Minimum Short Circuit Rating: equivalent to available short circuit capacity at installed location per one-line diagram.

## 2.3 EQUIPMENT SWITCH CONSTRUCTION

A. Transfer switch is to be mechanically held, electrically operated by a single solenoid or motor mechanism momentarily energized from the source to which the load is being transferred.

B. The switch shall be closed transition type rated for continuous duty and shall be inherently double throw, mechanically interlocked to ensure that normal or emergency positions don't coincide for greater than 100ms.

C. Load carrying parts shall have full 600 volt insulation and main contacts, as well as arcing contacts and shall be replaceable without disassembly of the operating mechanism or disconnection of power conductors.

D. The transfer switch shall consist of a power transfer module and a control module separately mounted. Control module shall be mounted on the inside surface of the enclosure door to facilitate safe adjustment and service. Harnessing between transfer module and control module shall have built-in disconnect.

E. The automatic transfer switch shall be suitable for use in emergency systems, listed by Underwriter's Laboratories for 30-cycle closing and withstand under Standard 1008 for total system transfer.

F. Transfer switch shall be mounted in NEMA 1 enclosure.

G. The transfer switches shall be capable of switching all classes of load and shall be rated for continuous duty when installed in a non-ventilated enclosure constructed in accordance with Underwriter's Laboratories, Inc. Standard UL-508.

H. The transfer switches shall be double throw, actuated by a single electrical operator momentarily energized and connected to the transfer mechanism by simple over center type linage with a total transfer time not to exceed ½ second. The transfer switches shall be capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.

I. The normal and emergency contact shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contact shall be mechanically locked in position in both the normal and emergency positions without use of hooks, latches, magnets or springs; and shall be silver tungsten alloy protected by arcing contacts with magnetic blowouts on each pole. Interlocked molded case circuit breakers or contactors are not acceptable.

J. The transfer switches shall be equipped with a manual operator per paragraph 14 of UL Standard 1008 that is designed to prevent injury to the operating personnel if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electric operator to prevent a flashover from switching the main contacts slowly. A mechanical visual indicator for the switch position shall be provided.

K. All relay, timers, control wiring and accessories shall be front accessible. Test switch and pilot lights shall be on front of cabinet door. The voltage sensing relays and all adjustable times shall be capable of being adjusted while energized through calibrated dials. All controls wire terminals shall be ring or locking spade terminals.

L. All wiring shall be identified by tubular sleeve-type makers.

## 2.4 TRANSFER SWITCH ACCESSORIES

A. The unit shall meet or exceed the voltage surge withstand capacity in accordance with IEEE Std. 472-1974 and impulse voltage withstand test in accordance with NEMA Std. ICS 1-109 when supplied with the following accessories:

1. Engine starting contacts, gold plated for low voltage DC service. Contacts to close on failure of normal source to initiate engine starting.
2. Auxiliary contact to open when normal fails.
3. Independent voltage and frequency sensing network to prevent transfer to emergency until generator voltage is 90% of nominal and generator frequency is 95% of nominal.
4. Time delay on engine starting .5 to 3 seconds adjustable time delay to ignore momentary outages, factory set at 3 seconds.
5. Adjustable time delay on retransfer to normal (motor driven type - 0 to 30 minutes) fixed 5 minute unloaded running time for cool-down of stand-by plant after retransfer to normal.

6. Solid State Close Differential Relay protection on normal. Three Close Differential Sensing Relays factory set for 90% pickup, 80% dropout. Relays are adjustable in the field.
7. Test switch momentary type to be mounted on cabinet. Provides for testing operation of emergency plant and transfer switch (simulates normal power failure).
8. Green Pilot Light for indicating switch in normal position.
9. Red Pilot Light for indicating switch in emergency position.
10. Auxiliary contact on main shaft (closed on normal).
11. Auxiliary contact on main shaft (closed on emergency).
12. In phase monitor bi-directional, operating independent of line voltage, to assure transfer between live sources in either direction within a 20 degree phase angle difference to protect system from abnormal motor inrush currents.

B. Ammeter shall be installed in each transfer switch.

## 2.5 REMOTE ANNUNICATORS

A. Remote annunciators/controllers for operation of the transfer switches and generators shall be provided as indicated on the plans. All necessary controls shall be provided to allow the system to normally operate in an automatic condition with controls that will allow manual start of the generator system and manual transfer of the transfer switches to meet code requirements for fire command centers and similar installation in substation for normal testing uses.

# PART 3 – EXECUTION

## 3.1 INSPECTION

A. Examine area to receive transfer switch to assure adequate clearance for switch installation.

B. Start work only after unsatisfactory conditions are corrected.

## 3.2 INSTALLATION

A. Install transfer switch in accordance with manufacturer’s written instructions and NEC.

## 3.3 FIELD QUALITY

A. Field test prior to start-up.

B. Megger check of phase-to-phase and phase-to-ground insulation levels.

C. Continuity.

D. Do not meggar check solid-state equipment.

E. Perform test according to transfer switch manufacturer’s instructions.

## 3.4 ADJUSTMENTS AND CLEANING

A. Clean adjustment of mechanism for free mechanical movement.

B. Tighten connections and mechanical fasteners.

C. Touch up scratched or marred surfaces to match original finish.

## 3.5 TRANSFER SWITCH AND REMOTE ANNUNCIATOR START-UP

A. Retain services of transfer switch manufacturer's factory trained technician to perform following services:

1. After engine/generator tests and after engine/generator set is electrically connected to automatic transfer switch, provide comprehensive demonstration of system maintenance and operation to Owner or Owner's Maintenance Personnel.
2. Include minimum of two simulated power failures.
3. Include minimum of two tests using remote annunciators (one from each panel) verifying that annunciation on each is consistent with the panel being used.

## 3.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Do not store indoor type equipment exposed to weather.

B. Protect system equipment from work of other trades.

END OF SECTION

## SECTION 26 50 00 - LIGHTING

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern work under this section.

### 1.2 SCOPE

A. Provide and install lighting fixtures and related accessories as indicted on the drawings and as specified herein.

B. Furnish and install the initial fill of lamps for all lighting fixtures. Lamps shall be of size and type as called for in the lighting fixture schedule and as recommended by the manufacturer. Where scheduled lamp types differ from that recommended by the manufacturer, the Contractor shall obtain approval from Engineer prior to furnishing lamps as recommended by the lighting fixture manufacturer.

C. Provide ballasts for fluorescent and high intensity discharge lighting fixtures as indicated on the drawings and as specified herein.

### 1.3 RELATED WORK

A. Section 26 05 26 – Grounding and Bonding for Electrical Systems

B. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables

C. Section 26 05 29 – Hangers and Supports for Electrical Systems

### 1.4 QUALITY ASSURANCE

A. Comply with the requirements of the following regulatory agencies:

1. National Fire Protection Association (NFPA) Chapter 70 - National Electric Code (NEC) and Wisconsin Amendments thereto.
2. Underwriters Laboratories (UL) Approval

B. Conform to the standards of the following agencies:

1. National Electrical Manufacturers Association (NEMA)
2. Certified Ballast Manufacturers Association (CBM)
3. American National Standards Institute (ANSI), ANSI C82.1.

C. Ballasts shall have the following approvals/certifications:

1. Certified Ballast Manufacturer's (CBM) Approval
2. Underwriters Laboratories (UL) Approval
3. Electrical Testing Laboratory (ETL) Certified

### 1.5 SHOP DRAWING SUBMITTALS

A. Submit manufacturer's printed data on lighting fixtures.

B. Submit fixture shop drawings in booklet form with index and a separate sheet for each fixture, assembled in luminaire “type” alphabetical order, with specified fixture and accessories clearly indicated on each sheet.

C. Submit copy of UL test report if requested by Engineer.

D. Include the following information as a minimum:

1. Dimensional informational.
2. Description of the fixture construction.
3. Lamps for use in that particular fixture.
4. Photometric test reports.
5. Any warnings regarding special requirements regarding the use of the lighting fixture.
6. Ballast information for use in that particular fixture.

## 1.6 WARRANTY

A. All lamps shall be guaranteed for 50% of rated life after date of final acceptance.

# PART 2 – PRODUCTS

## 2.1 GENERAL

A. Provide lighting fixtures of the size, type and rating indicated in “Lighting Fixture Schedule” complete with lamps, lampholders, reflectors, ballasts, starters, wiring and other equipment required for a complete working installation.

B. Fixture catalog numbers do not necessarily include all accessories required to complete the installation. Catalog numbers used in the Lighting Fixture Schedule are used to designate the fixture series, size and lamping requirements. Refer to the lighting fixture schedule notes for additional requirements.

C. Gasketing material for use in lighting fixtures shall be vinyl, neoprene or other non-aging type material as approved by Engineer.

D. Provide proper trim for each fixture as required for the various types of ceiling being installed throughout project. Provide the necessary plaster frames, fixture ends, caps, suspension units, mounting brackets, and/or other auxiliary parts required to complete the fixture installation.

E. All outdoor ballasts and ballasts in unheated areas shall operate to -20 deg. F (0 deg. F minimum for 48” rapid start lamp ballasts).

F. Ballasts shall comply with UL requirements with regards to thermal protection. Each ballast shall be equipped with thermal sensitive devices that will de-activate the ballast in the event higher than normal operating temperatures occur within the ballast. Internal protective devices shall be automatic resetting.

G. Use ballasts approved for low density ceilings where fixtures are mounted against such ceilings.

H. All remote mounted ballasts shall be installed in individual ballast enclosures designed to adequately dissipate generated heat in an ambient temperature of 100 deg. F (measured outside of the enclosure).

## 2.2 FLUORESCENT FIXTURES

A. Fabricate of sheet steel, die-formed to provide rigidity.

B. The color finish of each surface or pendant mounted lighting fixture is to be verified with the Architect at the time of shop drawing review.

C. Lens panels for fluorescent troffers shall be framed and be equipped with hinge and latch. Equip frames and louvers with retaining means to support frame during relamping.

D. Design fluorescent rapid start fixtures, 40W and smaller, to incorporate a grounded metal starting aid such as reflector, ballast channel strip, at least 1 in. wide over full length of lamp and within maximum ½ in. distance from lamp per ANSI C82.1.

E. Design fixtures such that case temperature of ballast does not exceed 90° C.

## 2.3 FLUORESCENT BALLASTS

A. All fluorescent ballasts shall be electronic type and shall meet the following specs:

1. UL Listed (Class P) sound rating A and CSA certified.
2. Comply with EMI and RFI limits set by the FCC (CFR 47 part 18) or NEMA and not interfere with normal electrical equipment.
3. Meet any applicable standards set forth by ANSI.
4. Be potted or conformal coated in a metallic case and not contain PCBs.
5. Provide normal rated lamp life as stated by lamp manufacturers (i.e. rated life at 3 hour burn time per start).
6. Provide independent test results from an approved testing laboratory for all of the specifications below. This is required for all submitted ballasts.
7. Nominal power factor of .90 or higher.
8. Total harmonic distortion of less than 10% at 120 or 277 volts (universal voltage).
9. **Ballast factor 0.87-0.88, unless noted on the plans.**
10. Frequency of operation shall be 40 kHz - 50 kHz and units shall operate without visible flicker.
11. Ballast efficiency factor shall meet Consortium of Energy Efficiency (www.cee1.org) specifications (adopted by Focus on Energy program).
12. Multi-lamp ballasts shall operate in parallel so that when one lamp burns out, the other lamps will continue to operate at full light output.
13. Ballasts shall carry a minimum 5 year warranty with a $10 replacement labor allowance.
14. Ballasts shall not be affected by lamp failure.
15. Ballasts shall be a standard production item.
16. Ballasts shall be marked with manufacturer's name, part number, supply voltage, power factor, open circuit voltage, current draw for each lamp type and UL Listing.
17. Ballasts shall withstand line transients as defined in IEEE 587, Category A.
18. Octron T8 lamp starting temperature of -20ºF.
19. SYSTEM PERFORMANCE: System performance for T8 instant-start ballasts shall be as follows:

Instant-Start, Low Ballast Factor (BF = 0.77-0.78)

| Lamps | Nominal Lamp Watts | System Input (Max. Watts @ Univ Volt) |
|---|---|---|
| 1 – F32T8 | 32 | 25 |
| 2 – F32T8 | 32 | 48 |
| 3 – F32T8 | 32 | 73 |
| 4 – F32T8 | 32 | 96 |

Instant-Start, Normal Ballast Factor (BF = 0.87-0.88)

| Lamps | Nominal Lamp Watts | System Input (Max. Watts @ Univ Volt) |
|---|---|---|
| 1 – F32T8 | 32 | 28 |
| 2 – F32T8 | 32 | 56 |
| 3 – F32T8 | 32 | 83 |
| 4 – F32T8 | 32 | 108 |

Instant-Start, High Ballast Factor (BF = 1.15-1.20)

| Lamps | Nominal Lamp Watts | System Input (Max. Watts @ Univ Volt) |
|---|---|---|
| 1 – F32T8 | 32 | 38 |
| 2 – F32T8 | 32 | 74 |
| 3 – F32T8 | 32 | 111 |
| 4 – F32T8 | 32 | 144 |

20. SYSTEM PERFORMANCE: System performance for T8 programmed-start ballasts shall be as follows:

Programmed-Start, Low Ballast Factor (BF = 0.71)

| Lamps | Nominal Lamp Watts | System Input (Max. Watts @ Univ Volt) |
|---|---|---|
| 1 – F32T8 | 32 | 25 |
| 2 – F32T8 | 32 | 47 |
| 3 – F32T8 | 32 | 73 |
| 4 – F32T8 | 32 | 93 |

Programmed-Start, Normal Ballast Factor (BF = 0.88)

| Lamps | Nominal Lamp Watts | System Input (Max. Watts @ Univ Volt) |
|---|---|---|
| 1 – F32T8 | 32 | 31 |
| 2 – F32T8 | 32 | 60 |
| 3 – F32T8 | 32 | 88 |
| 4 – F32T8 | 32 | 118 |

Programmed-Start, Normal Ballast Factor (BF = 1.15)

| Lamps | Nominal Lamp Watts | System Input (Max. Watts @ Univ Volt) |
|---|---|---|
| 1 – F32T8 | 32 | 38 |
| 2 – F32T8 | 32 | 75 |
| 3 – F32T8 | 32 | 110 |
| 4 – F32T8 | 32 | 146 |

Acceptable ballast manufacturer's names and product lines are as follows:
Osram Sylvania – Quicktronic High Efficiency and Quicktronic PROstart.
GE Lighting – Ultramax and UltraStart.
Maxlite – High Efficiency Ballast.
Advance – Optanium.
Universal Lighting Technologies – F32T8.

## 2.4 COMPACT FLUORESCENT BALLASTS (ELECTRONIC)

A. Ballasts shall be high power factor, class P, with voltage rating matching the branch circuit voltage.
B. Ballast factor shall be 0.95 or higher.
C. Ballast shall have lamp fault shut-off circuitry to prevent starting of a faulty lamp.
D. Cold-weather ballast must reliably start and operate the lamp in ambient temperatures down to 0ºF for the rated life of the lamp.

## 2.5 DIMMING ELECTRONIC BALLASTS (Fluorescent)

A. Ballast shall provide continuous, flicker-free dimming from 100% to 3% (for compact fluorescent), or 5% (for T8 lamps) or 1% (for T5 lamps).
B. Ballasts shall be analog (0-10 volt) 4-wire type.
C. Ballast shall have Total Harmonic Distortion of less than 10%.
D. Ballast power factor shall be greater than 0.85 (for T8 lamps) or 0.95 (for T5 lamps).
E. Ballast factor shall be 1.0 for T5 and compact fluorescent lamps.
F. Ballast shall be high frequency electronic type and operate lamps at a frequency above 25kHz for T5 lamps.
G. Ballast shall have built-in inrush current limiting circuitry, maximum of 7 amps for 120 volts and 3 amps for 277 volts.
H. Ballast shall have internal fusing.
I. Ballast shall have ultra-quiet operation.
J. Operating temperature shall not exceed 75º C on the case during normal operation.
K. Minimum lamp starting temperature shall be 10ºC / 50º F.
L. Ballasts shall be equal to Universal SuperDim series.

## 2.6 LAMPS

A. Four Foot Fluorescent Lamps: High Performance T8 Lamps:
   1. Minimum 3100 initial lumens and minimum of 2945 mean lumens.
   2. Minimum 36,000 hour rated life at three-hour starts.
   3. Color Rendering Index (CRI) of 85 or higher.
   4. 3500ºK color temperature, unless noted on plans.
   5. Lamps shall be suitable for use with instant start ballasts and occupancy sensors.
   6. Lamps shall meet “TLCP” requirements for low mercury.
   7. Mean system efficiency equal to 90MLPW minimum, with instant start ballasts.

Acceptable lamp manufacturers and catalog numbers are (or equal):
Sylvania F032/835/XPS/ECO

Manufacturer names and catalog numbers are used to develop quality and performance requirements only. Lamps manufactured by others will be accepted provided they meet or exceed the specifications.

B. Compact Fluorescent Lamps:
   1. Compact fluorescent lamp temperature shall be 4100ºK unless noted on the plans with a color rendering index (CRI) at or above 80. See lighting fixture schedule on drawings.

C. All lamps shall be new.

## 2.7 HID BALLASTS

A. Physical Requirements:
   1. Core and coil shall be vacuum impregnated with silica-filled polyester resin.
   2. Core and coil shall use pre-insulated individual input voltage leads; floating lead and tab terminals are not acceptable.
   3. Oil-filled capacitors shall be housed in corrosion-resistant steel or aluminum cans and contain ¼” quick disconnect terminals.
   4. Dry capacitors shall be housed in a flame-retardant thermoplastic case with lead wire terminations and have no exposed live parts.
   5. Igniters shall be polyester filled with either a plastic or aluminum external housing.
   6. HID ballast kits with igniters shall have the igniters pre-wired to the core and coil, and have push-in connectors installed on the core and coil “cap” leads.

B. Lighting Performance Requirements:
   1. Ballasts shall be designed to provide reliable lamp starting down to –40ºC for High Pressure Sodium, -30ºC for probe-start Metal Halide, and –30ºC / -40ºC for pulse-start Metal Halide lamps (depending on lamp specifications).

C. Electrical Performance Requirements:

1. Capacitors shall be 100ºC dry type where rated voltage is ≤400, and contain bleeder resistors where required by UL. All oil -filled capacitors shall contain an internal protective device.
2. Igniter shall be designed to operate an average of 10,000 hours at a case temperature of 75ºC.
3. Igniter shall be 105ºC rated.

D. Regulatory Requirements:
1. Ballast shall be designed and manufactured in accordance with the ANSI Standard for HID Ballasts, ANSI C82.4.
2. Ballast shall be UL recognized in accordance with UL 1029 Standard for HID Ballasts or CSA certified in accordance with CAN/CSA-22.2 No. 74-92.
3. Manufacturer shall provide written warranty against defects in workmanship for two years.

## 2.8 METAL HALIDE HIGH FREQUENCY ELECTRONIC BALLASTS

A. Ballast variation in output power shall be +/- 0.5%.
B. Ballast variation in input voltage shall be +/- 10%.
C. Ballast shall be equipped with safety shutdown feature to prevent excessive pulsing of failed lamps.
D. Ballast shall have Total Harmonic Distortion of less than 10%.
E. Ballast power factor shall be greater than 0.95.
F. Ballast shall be thermally protected to shut off when temperatures reach unacceptable levels.
G. Ballast shall have an acceptable remote mounting distance of not less than 15 feet.

## 2.9 INCANDESCENT FIXTURES

A. Provide porcelain lampholders in fixtures. Recessed incandescent fixtures shall be thermally protected in accordance with NEC Article 410.

B. Lamps:
1. All incandescent lamps shall be long life style (min. of 8000 hours) with 130-volt rating and brass screw shells manufactured by Duro-Test.
2. All incandescent “A” type and “PS” type lamps shall be frosted.
3. Lamps mounted in recessed alzak reflector downlights shall be furnished with the proper diameter, maximum overall length and light center length as recommended by the fixture manufacturer to achieve proper alignment of the lamp within the reflector. Where fixtures have adjustable lamp sockets, adjust the socket position for the proper position with the lamp used.

## 2.10 LENSES

A. Plastic fixture lenses and diffusers, 100% virgin acrylic material. Lenses minimum .125 average thickness.

## 2.11 STEMS

A. Where stems are furnished by fixture manufacturer, he shall verify length prior to releasing for shipment.

B. Where stems are furnished by Contractor, he shall verify length prior to installation.

C. Suspended fixtures shall have swivel type aligner hangers in ceiling outlet boxes to ensure plumb suspension.

## PART 3 – EXECUTION

### 3.1 INSPECTION

A. Install lighting fixtures of type indicated where shown on drawings and at indicated heights.

B. Install in accordance with manufacturer's written instructions.

C. Fasten fixtures securely to indicate structural support members.

D. Install pendant fixtures plumb.

E. Provide proper bushing for wire entrances. Ground fixture chassis to conduit system.

F. Coordinate with trades so lighting fixtures are properly aligned with items such as diffusers, grilles and speakers. If necessary, relocate fixtures as directed so there will be no conflict with other equipment.

G. Mount stem mounted fixtures with swivel aligners and stem lengths as required. Verify stem lengths.

H. Make fixture holes for wire entrance with knock-out punches or hole saw, remove burrs. Do not cut holes with tin snip.

I. Special care shall be taken to assure light-tight joints between recessed fixtures and ceiling.

J. Recessed lighting fixtures which are installed in a rough textured ceiling surface whereby light may be emitted between fixture frame and ceiling surface shall have black self-adhesive polyfoam gasketing installed around inside edges of frame to prevent leaks.

K. Care shall be taken in placement of outlets and surface-mounted fixtures to maintain alignment, spacing, layout and general arrangement shown on drawings. Contractor may vary these dimensions slightly in order to clear obstructions. Any major changes in the arrangement must be approved by Engineer.

L. Install tandem fixtures in continuous rows providing that finished appearance conforms to appearance of individual units.

M. Align and plumb rows of light fixtures.

N. Provide additional trim as required for neat plumbing of recessed fluorescent lights mounted in patterns.

O. Mount wall and ceiling fixtures independent and secure so that they are not dependent on finish for support and cannot be rotated or displaced.

P. Maintain clearances as required in Section 410.66 of the NEC. Notify Engineer of any conflict, prior to rough-in.

### 3.2 FIXTURE SUPPORTS

A. See Section 26 05 29 for fixture support items such as device procedures and retaining clips.

B. Surface or pendant mounted lighting fixtures weighing in excess of 25 pounds shall be securely supported to the outlet box through the use of a fixture stud. The stud shall attach to the box through a knockout in the top of the box. Fixture support shall not be solely dependant on the ears of the box.

C. Securely attach outlet boxes to the building structure either directly to the structure or through the use of a threaded rod or steel channel.

D. The contractor is required to determine and provide all necessary mounting hardware, plates, supports, etc. as required, and finished in a color per architect's requirements to install fixtures in locations as indicated on the plans.

## 3.3 ADJUST, CLEAN AND LUBRICATE

A. Clean lighting fixtures of dirt and debris prior to acceptance. Cleaning shall include lamps, reflectors, lenses, louvers and exposed trims and housing.

B. Protect installed fixtures from damage during the construction period.

C. Remove conspicuous trade labels.

D. Aim adjustable fixtures to satisfaction of Engineer. Adjustable exterior lighting fixtures, such as floodlights, shall be aimed after dark.

## 3.4 FIELD QUALITY CONTROL

A. All lamps shall be new and delivered to the job site in sealed cartons.

B. At time of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Engineer.

## 3.5 PRODUCT STORAGE AND HANDLING

A. Handle lighting fixtures carefully to prevent breakage, denting and scoring finish.

B. Do not install damaged lighting fixtures.

C. Do not repair damaged fixtures; replace and return damaged units to equipment manufacturer for repair.

D. Store lighting fixtures in a clean, dry space. Store in original cartons and protect from dirt, physical damage, weather and construction traffic.

## 3.6 JOB CONDITIONS

A. Contractor shall determine that ceiling suspension system is adequately supported to receive and support the lighting fixtures. Where deemed inadequate, do not install fixtures until additional support has been provided.

B. Verify local codes and ordinances that may pertain to installation and aiming of exterior fixtures. Notify Engineer prior to Bid time if problems are encountered.

END OF SECTION

**SECTION 27 00 00**
**COMMUNICATIONS CABLE AND EQUIPMENT**

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable provisions of Division 1 shall govern all work under this Section.

B. Unless noted otherwise, "Contractor" shall refer to the Telecommunications Contractor.

### 1.2 SCOPE

A. This section describes the products and execution requirements relating to furnishing and installation of Telecommunications Cabling and Termination Components and related sub-systems as part of a Structured Cabling System. Horizontal (Station) cabling comprised of Copper Cabling is covered under this document.

B. The Horizontal (Station) Cabling System is based on the installation of 4-Pair Unshielded Twisted Pair (UTP) DATA (Category 5e) and 4-Pair UTP VOICE (Category 3 or 4) Copper Cables. The cables shall be installed from the Standard Information Outlet (SIO) in the work area to the Telecommunications Closet (TC) serving that area and terminated as specified in this document.

C. Station cables shall be installed in conduit and in modular furniture. Outlets shall be mounted flush on a wall-mounted box, on Surface Raceway and in Modular Furniture Information Outlet locations are to be identified on Project Drawings.

D. At the Equipment Rooms, Data cable terminations shall be mounted on equipment racks; termination hardware related to Voice Cabling shall be wall mounted.

E. All cables and related termination, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following section[s].

F. The Contractor shall provide all labor and materials necessary to construct the system as described herein. This includes - but is not limited to - furnishing and installing cable, cable supports, innerduct, racking and termination components, termination, testing, labeling and documentation.

G. Basic Electrical Requirements are applicable to all Division 26 and 27 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.

H. All work for removals, temporary and permanent installation shall be coordinated with the Owner's IT staff.

### 1.3 RELATED WORK

A. Section 26 05 00 – Common Work Results for Electrical

B. Section 26 05 26 – Grounding and Bonding for Electrical Systems

C. Section 26 05 29 – Hangers and Supports for Electrical Systems

D. Section 26 05 33 – Raceway and Boxes for Electrical Systems

E. Section 26 27 26 - Wiring Devices

F. Section 27 05 00 – Common Work Results for Communications

## 1.4 REGULATORY REFERENCES

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Wisconsin Electrical Code and present manufacturing standards.

B. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

C. Other applicable standards are as follows:

1. ANSI/IEEE C2 - National Electrical Safety Code
2. NFPA 70-1999 - National Electrical Code
3. COMM Chapter 16 - Wisconsin Electrical Code
4. TIA/EIA Standards 526-14A (OFSPT-14), 526-7 (OFSPT-7), SP4195A (Draft 468A; re: Category 5E)
5. TIA/EIA Standards 568-A (incl. TSB-67), 569 and 607
6. IEEE/ANSI 142-1982 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

## 1.5 WORK SEQUENCE

A. During the construction period, coordinate telecommunications schedule and operations with the Owner.

B. For additional information pertaining to the sequencing of the work refer to Article 13 of the General Conditions.

C. Installation shall be sequenced to accommodate the Owner's occupancy requirements. See Division 1, General Conditions (Work Sequence).

## 1.6 SUBMITTALS

A. Under the provisions of Section 26 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Six (6) sets of Manufacturers Data covering <u>all</u> products proposed indicating construction, materials, ratings and all other parameters identified in Part 2 (Products) below.

2. Manufacturer’s installation instructions.

B. Submittals should be grouped to include complete documentation of related systems, products and accessories in a single submittal. Where applicable, dimensions should be marked in units to match those specified.

C. Submittals shall be original catalog sheets or photocopies thereof. Facsimile (fax) sheets <u>shall</u> <u>not</u> be accepted.

D. Work shall not proceed without the Engineer's approval of the submitted items.

E. If materials are furnished as specified no further qualifications is necessary, except for items requiring shop drawings. However, if the Contractor wishes to substitute another manufacturer and/or catalog number, the following information in triplicate shall be submitted to the Engineer:

1. A complete description of the material which the contractor proposes to substitute (shop drawings, illustrations, catalog data, performance characteristics, etc.) and the reason for the substitution identifying any benefit to the Owner.
2. The Contractor shall receive approval from the Engineer on all substitutions of material. No substituted materials shall be installed except by written approval from the Engineer.

## 1.7 PROJECT RECORD DOCUMENTS

A. Submit and record documents under provisions of 26 05 00.

B. Accurately record exact sizes, locations and quantities of cables.

## 1.8 QUALITY ASSURANCE

A. The manufacturer shall be a company specializing in communication cable and/or accessories with a minimum of five years documented experience in producing cable and/or accessories similar to those specified below.

B. The contractor shall have been in this line of business for a minimum of five (5) years and completed four (4) jobs of the magnitude specified in the following sections.

C. The installing contractor shall have at a minimum one (1) Certified Installer trained to the latest industry standards to ensure the most reliable installation available. The Certified Installer shall have been trained by a company(s) that offer a minimum fifteen (15) year system warranty.

## 1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver products to and receive products at the site under provisions of Division 1, General Requirements.

B. Cable shall be stored according to manufacturer's recommendations as minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location.

C. If the contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner. If necessary, cable shall be stored off site at the contractor's expense.

## 1.10 DRAWINGS

A. It shall be understood that the electrical and telecommunication details and drawings provided with the specification package are diagrammatic. They are included to show the

intent of the specifications and to aid the Contractor in bidding the job. The Contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.

B. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.

C. Prior to submitting the bid, the Contractor shall call the attention of the Engineer to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted, within ten (10) days prior to the Bid Due Date.

## PART 2 - PRODUCTS

### 2.1 HORIZONTAL MEDIA (STATION CABLES) - PLENUM

A. General

1. The Horizontal (Station) Cable System is based on the installation of Un-shielded Twisted Pair (UTP) DATA (Category 5e) and VOICE (Telephone; Category 3 or 4) copper cables to installed from the work area to the wiring hub locations(s). Refer to the Floorplan Drawings(s) which identify the location of the Telecommunications Closets (TC) and Standard Information Outlets (SIO) locations.
2. Voice and Data Station Cables shall be constructed of individually twisted pairs with 24-AWG insulated solid copper conductors.
3. All Cables and Termination hardware shall be technically compliant with and installed in accordance with the referenced TIA/EIA documents.
4. All cables shall be suitable for installation in the environment defined and shall meet a CMP (Plenum) rating.
5. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code and shall meet the specifications of NEMA (low loss), UL 444, and ICEA.
6. All cables, termination components and support hardware shall be furnished, tested, installed and wired by the Contractor.

B. Data Station Cable (Copper)

1. All horizontal Data Station Cables shall terminate on modular Patch Panels in their respective Telecommunications Closets (TC).
2. Transmission characteristics of the Data Station Cables shall meet full Category 5e "Enhanced" performance criteria as defined by the referenced TIA/EIA documents.
3. The cable shall meet the following specifications:

   a. Twisted Pair 24 gauge
   b. Impedance 100 ohms +/- 15% @ 1 – 16MHz
   c. Attenuation (dB/100 meters @ 20 deg. C)
      2.0 @ 1 MHz
      4.1 @ 4 MHz
      6.5 @ 10 MHz
      8.2 @ 16 MHz
      9.3 @ 20 MHz
      22.0 @ 100 MHz
   d. Mutual Capacitance < 5.6 nF/100 meters
   e. Propagation Delay (max.) 570 ns/100 m

f. Delay Skew (max.) 45 ns/100 m (1 – 100 MHz)

g. UTP Data Cabling (Category 5e) Near End Cross-Talk (NEXT) Loss shall be tested over each pair with all other pairs energized (Power Sum). All pair combinations should be considered. Worst-Pair Near-End Crosstalk (PS-NEXT; dB) shall be as follows:

65.3 @ 1 MHz
56.3 @ 4 MHz
50.3 @ 10 MHz
47.3 @ 16 MHz
45.8 @ 20 MHz

4. The jacket color for Data cables shall be BLUE or PINK.
5. Cable shall be packaged in a way that minimizes tangling and kinking of the cable during installation. Examples are open reels or packages that incorporate a rotating reel.

C. Horizontal Voice Station Cable (Copper)

1. All horizontal Voice Station Cables shall terminate on 110 type wall mounted termination blocks in their respective TC.
2. All cables, termination components and support hardware shall be furnished, tested, installed and wired by the Contractor.
3. Transmission characteristics of the Voice Station Cables shall meet full Category 3 or 4 performance as defined by the referenced TIA/EIA documents.
4. The Cable shall meet the following specifications.

a. Twisted Pair 24 gauge
b. Impedance 100 ohms +/- 15% @ 1 MHz
c. Attenuation 2.6 dB/100 meters @ 1 MHz
d. The jacket color for “Voice” cables shall be WHITE or GRAY or BEIGE.

D. Information Outlet

1. General

a. Station cables shall each be terminated at their designated workstation location in the connector types described in the sub-sections below. Included are modular jacks (Voice & Data), Fiber Optic Connectors and Coaxial Connector assemblies. These connector assemblies shall snap into a mounting frame and exit at an angle. The purpose of the angled ports is to relieve stress on equipment cords. All ports shall be installed such that the opening faces the floor. The combined assembly is referred to as the Standard Information Outlet (SIO).

2. SIO mounting configurations shall be as follows:

a. Flush where existing boxes are in place
b. In surface raceways
c. Surface mounted on Systems Furniture (base panel) - Systems Furniture Type shall be defined prior to construction.
d. All data jacks shall exit the frame at a 45 degree angle with the angle facing the floor.

3. The Telecommunications Outlet Frame shall accommodate:

a. A minimum of four (4) Modular Jacks, Fiber Optic Connectors and/or Coaxial Connectors when installed on a wall-mounted assembly.
b. A minimum of two (2) Modular Jacks and/or Coaxial Connectors when installed on modular furniture.
c. The outlet frame shall incorporate a mechanism for adjusting the surface plate to a plumb position.

4. Multiple Jacks - identified in close proximity on the drawings (and not separated by a physical barrier) - may be combined in a single assembly. The contractor shall be responsible for determining the optimum compliant configuration based on the products proposed and documenting these in the as-built records.
5. The same orientation and positioning of Jacks and Connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each SIO type for review by the Engineer.
6. Wall Mount Outlet Faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
7. Where stand-alone "Data" or "Voice" only Jacks are identified, the SIO Frame shall be configured as to allow for the addition of one (1) additional jack (Voice or Data) to be installed to supplement each such Jack as defined by this project. The installation of these supplemental Jacks IS NOT part of this project.
8. Any unused jack positions shall be fitted with a removable blank inserted into the opening.
9. The faceplate of the SIO shall be constructed of high impact plastic. Faceplate color shall (1) match the faceplate color used for other utilities in the building or (2) when installed in Surface Raceway (if applicable), match the color of that Raceway.
10. Different frame designs for locations, which include fiber optic cabling relative to those, which terminate only Copper Cabling (UTP and/or Coax) are acceptable. Outlets which incorporate optical fiber shall be compliant with the above requirements plus:

    a. be a low-profile assembly,
    b. incorporate a mechanism for storage of cable and fiber slack needed for termination,
    c. position the fiber optic couplings to face downward or at a downward angle to prevent contamination and,
    d. incorporate a shroud that protects the optical couplings from impact damage.
11. Wall-mounted "Voice Only" outlets shall be installed where identified on the Floorplan Drawings to accommodate wall-mounted telephone sets. The Wall Plate shall be of Stainless Steel construction, accommodate one (1) voice jack as defined below, mount on a standard single gang outlet box or bracket and include mating lugs for wall phone mounting.
12. All Standard Information Outlets and the associated Jacks shall be of the same manufacturer throughout the project. An allowable exception, however, is the Wall-mounted "Voice Only" Outlet described above.

E. Data Jack

1. Data jacks shall be an 8-pin Modular Jack.
2. The interface between the jack and the station cable shall be a 110-Style block or insulation displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination

3. Data Jacks shall be pinned per TIA-568B (equivalent to AT&T 258A) with the pairs as follows:

   Pair 1 - Pins 5 & 4
   Pair 2 - Pins 1 & 2
   Pair 3 - Pins 3 & 6
   Pair 4 - Pins 7 & 8

4. Transmission characteristics of the Data Jack shall be as required to meet the TIA/EIA Category 5e "Enhanced" performance criteria. Refer to the Execution Section which details the required performance criteria of the completed Link of which the Jacks are a part.
5. The Jack shall be UL verified and listed.
6. Jack contacts shall have a minimum of 50 micro-inches of gold plating.
7. The color of the Data Jack shall be orange. Where used for another application a color unique from the data and voice jack shall be used. Alternately, a color-coded Bezel or Icon may be used to identify the Data Jack.

F. Voice Jack

1. Voice jacks shall be non-keyed 8-pin Modular Jack (8P8C)
2. The interface between the jack and the station cable shall be a 110-Style block or insulation displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
3. Voice Jacks shall be pinned per the USOC standard with the pairs as follows:

   Pair 1 - Pins 5 & 4
   Pair 2 - Pins 3 & 6
   Pair 3 - Pins 2 & 7
   Pair 4 - Pins 1 & 8

4. Voice Termination hardware shall meet Category 3 or 4 performance specifications as defined by the referenced EIA/TIA documents.
5. The color of the Voice Jack shall be white. Alternately, a color-coded Bezel or Icon may be used to identify the Voice Jack.

## 2.2 DATA CABLING TERMINATIONS

A. Existing data patch panels shall be used.

## 2.3 VOICE CABLING TERMINATIONS

A. Existing voice blocks shall be used.

## 2.4 SURFACE RACEWAY

A. If surface raceway is required and approved by the Engineer and Owner, installation shall comply with this section.

B. No exposed wire shall be permitted.

C. With the agreement of the Architect/Engineer, if a need arises to add telecommunications outlets in areas where the walls cannot be fished, the station wire serving these outlets shall be covered with raceways. No exposed wire shall be permitted within offices, laboratories, conference rooms or like facilities.

D. The raceway shall originate from a surface mounted box located eighteen inches (18") off the floor and be attached to the wall and terminate above the ceiling. Raceway for a wall-mounted location shall originate from a surface mounted box located 48" off the floor.

E. The color of this raceway shall be ivory. All fittings including, but not limited to, extension boxes, elbows, tees, fixture boxes shall match the color of the raceway.

F. The raceway and all system devices must be UL Listed, exhibit nonflammable self-extinguishing characteristics, tested to specifications of UL94V-0 and be Category Compliant as defined by TIA/EIA 568A.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Contractor shall meet with Owner's IT personnel prior to installation, to review plans and discuss exact location, type, and quantity of devices required, and equipment sizes.

B. Contractor shall furnish and install all cables, connectors and equipment as shown on drawings and as specified above. It shall be noted that all cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

C. It is the contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified. This includes any modifications required to route and conceal horizontal distribution wiring.

D. Beginning installation means contractor accepts existing conditions.

E. Contractor shall furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jacks, duct entrance tunnels, pulling tension gauge and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices, which may move or wear in a manner to pose a hazard to the cable, shall not be used.

F. All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to insure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a "break-away" or other approved method.

G. The contractor will be responsible for identifying and reporting to the Site Coordinator(s) any existing damage to walls, flooring, tiles and furnishings in the work area prior to start of work. All damage to interior spaces caused by the installation of cable, raceway or other hardware must be repaired by the Contractor. Repairs must match preexisting color and finish of walls, floors and ceilings. Any contractor-damaged ceiling tiles are to be replaced to match color, size, style and texture.

H. Where unacceptable conditions are found, the Contractor shall bring this to the attention of the construction supervisor immediately. A written resolution will follow to determine the appropriate action to be taken.

I. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.

J. Cable pulling shall be done in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed. If any installed cable is kinked to a radius less than recommended dimension it shall be replace by the contractor with no additional cost to the project.

K. All wiring shall be run "free-air", in conduit, in a secured metal raceway or in modular furniture as designated on the floorplan(s). All cable shall be free of tension at both ends.

L. Avoid abrasion and other damage to cables during installation.

M. Pulling Lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.

N. The Cable system will be tested and documented upon completion of the installation as defined in the Section below.

O. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

## 3.2 SYSTEM TOPOLOGY AND CABLE SIZE REQUIREMENTS

A. There is no voice and data riser schedule. The intent is to run all cabling to nearest TC.

B. Station Cabling

1. Information Outlets cables with copper media (Voice & Data UTP) shall be located as detailed on the Project Drawings.
2. The Bidder in determining materials quantities and routing should utilize these documents.
3. Station cables shall be run to the Information Outlet from the Telecommunications Closet serving each area in conduit, in floor duct and/or in modular furniture.
4. The maximum station cable drop length for Data UTP shall not exceed 295-feet (90-meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing station cabling in a fashion as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Engineer prior to installation. Changes to the plan shall be approved by the Engineer.
5. All cables shall be installed splice-free unless otherwise specified.
6. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.
7. Avoid abrasion and other damage to cables during installation.
8. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellem grips may be used to spread the strain over a longer length of cable.

9. Where installed free-air (telecommunications closets) , installation shall consider the following:

    a. Cable shall run at right angles and be kept clear of other trades work.
    b. Cables shall be supported according to code utilizing "J-" or "Bridal-type" mounting rings anchored to ceiling concrete, piping supports or structural steel beams. Rings shall be designed to maintain cables bend to larger than the minimum bend radius (typically 4 x cable diameter).
    c. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If cable "sag" at mid-span exceeds 6-inches, another support shall be used.
    d. Cable shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
    e. Cables shall not be attached to existing cabling, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.

10. Manufacturers minimum bend radius specifications shall be observed in all instances.
11. Care should be taken in the use of cable ties to secure and anchor the station cabling. Ties should not be over tightened as to compress the cable jacket. No sharp burrs should remain where excess length of the cable tie has been cut.
12. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
13. A coil of 4 feet in each cable shall be placed in the ceiling at the last support (e.g.. J-Hook, Bridal Ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service Pole, approximately 15-feet of slack shall be left in each station cable under 250-feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
14. To reduce or eliminate EMI, the following minimum separation distances from ≤480V Power lines shall be adhered to:

    a. Twelve (12) inches from power lines of <5-kVa.
    b. Eighteen (18) inches from high voltage lighting (including fluorescent).
    c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
    d. Thirty-nine (39) inches from transformers and motors.

15. All openings shall be sleeved and firestopped per prevailing code requirements upon completion of cable installation.

C. Station Cabling on Modular Furniture

1. Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via existing conduit.
2. Where modular furniture is installed without wall contact, the contractor shall install a power pole and route the station cabling via the power pole. The selection of the power pole shall consider fill ratios, bend limits on the Cat. 5 UTP and the eventual feed into the furniture partition.
3. Cabling shall be protected in the transition from the power pole or Wall Fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the power pole and Wall Fittings proposed. There shall be no exposed cable in the transition to the

modular furniture. Fill Ratio (Cable Area vs. Conduit Area) in each feed shall not exceed 40%.

4. For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.
5. For purposes of bidding, it is to be assumed that it will be the responsibility of the Contractor to punch and re-install the bottom molding panels on the modular furniture as required to accommodate the Communications cabling and SIOs. The panels shall be marked prior to installation by the owner to identify the desired location of the SIOs. Any discrepancy between the Project Drawing identifying Outlet locations and the markings should be brought to the attention of the Site Coordinator(s).
6. The SIO shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the SIO to the panel shall not result in sharp protrusions (e.g. sheet metal screw tip) into the channel behind the panel.

D. Information Outlet

1. General:

   a. Information Outlets shall be flush mounted on wall-mounted boxes, on Surface Raceway and on modular furniture.

2. Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by the Site Coordinator and the Engineer. Nominal height (from finished floor to center line of Outlet) in new installation shall be as follows:

   a. Standard Voice & Data Outlet 18-inches
   b. Wall-Mounted Telephone Outlet (Standard Voice only) 54-inches.
   c. Wall-mounted Telephone Outlets for Wheelchair Persons:

| | |
|---|---|
| Approach head on | per ADA regulations |
| Approach parallel | per ADA regulations |

## 3.3 CABLE TERMINATION

A. General:

1. At the Telecommunications Closets, all Data and Voice Cables shall be positioned on termination hardware in sequence of the Outlet I.D. starting with the lowest number.
2. Termination Hardware (Blocks and Patch Panels) Positioning and Layout must be reviewed and approved by the Owner’s rep prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.

B. Cable Termination - Voice UTP

1. Voice pairs shall terminate on wall mounted 110 type blocks at the Main Equipment Room and Telecommunications Closet.
2. Station Blocks shall be provided to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.
3. The contractor shall furnish and install cable management hardware (e.g. D Rings and cable guides) to neatly and securely route the cable from cable tray to the cable termination hardware.

4. The Height of the Voice Termination Field shall not exceed 6-feet (72-inches) above floor level to facilitate cable maintenance.
5. Blocks on which Backbone and Station Cabling are terminated shall be positioned in separate columns. Backbone Cabling should be positioned to the Left; Station cabling to the Right and be in close proximity as to simplify installation and subsequent tracing of cross-connect wiring. Where new cabling is to be integrated with existing cabling at the building entrance, it will be the responsibility of the Contractor, in cooperation with the Owner, to coordinate placement of Voice Termination hardware the Local Exchange Carrier(s) serving the site.
6. Cables shall be fed from below the Termination Hardware in a manner that will facilitate growth.
7. Horizontal Troughs incorporating split plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block. Rings shall be positioned between the Backbone and Station blocks for vertical routing of jumpers and/or cross-connect wiring.
8. Termination of Horizontal Voice (Station) cabling shall be accomplished by using four-pair (e.g. C4-type) clips. The twenty-fifth pair of each row on the 110 type block located in the IDF shall not be used for termination of horizontal voice cable.
9. Termination of Backbone Voice cabling shall be accomplished by using five-pair (e.g. C5-type) clips.
10. The installer shall insure that the twists in each cable pair are preserved to within 1.0-inch of the termination for all Voice UTP cables. The cable jacket shall be removed only to the extent required to make the termination.
11. A jumper wire spool holder shall be installed at the Main Equipment Room. Two full (1000-foot) spools of 24-AWG one-pair jumper wire, - one spool each white-blue/blue and white-green/green - shall be supplied with the holder. The spool holders shall be assemblies designed for that purpose.

C. Cable Termination - Data UTP

1. Data Patch Panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.
2. Data Patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.
3. At Information Outlets and Data Patch Panels , the installer shall insure that the twists in each cable pair are preserved to within 0.5-inch of the termination for Data cables. The cable jacket shall be removed only to the extent required to make the termination.

D. Voice Cross Connects

1. This contractor shall be responsible for the “Cross-connect” wiring between the Station and Backbone Voice cabling.
2. Four (4) pairs in each station cable shall be cross-connected to the Backbone (riser or tie) cable. 4-pair Cross-connect wire, color coded to identify each pair, shall be used. The $25^{TH}$ pair position ($50^{TH}$, $75^{TH}$, etc.) of each riser voice block shall remain vacant.
3. Fastening cables directly to support brackets with wire or plastic ties will not be accepted. All cabling shall be neatly laced, dressed and supported. Retainer Clips shall be used on each 110-type block to secure jumper wires on the wiring block(s).

4. The contractor shall be responsible for cross-connects between the cabling terminations at the Entrance Room and the SNI. It shall be the responsibility of the Contractor, to work with the Owner and Site Coordinator(s) and provide the necessary assistance to allow Owner and/or Telephone Company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross connect documentation, general wiring overview and cable pair identification.
5. The contractor shall be responsible for removal and disposal of all existing station cable.

## 3.4 IDENTIFICATION AND LABELING

A. All Copper Backbone and Station Cables, Outlet Faceplates and Termination components (e.g. Voice Field & Data Patch Panel) shall be clearly labeled.

## 3.5 COOPERATION

A. The Contractor shall cooperate with other trades and Owner personnel in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

## 3.6 TESTING AND ACCEPTANCE

A. General:

1. The contractor is responsible to perform acceptance tests as indicated below for each sub-system (e.g. backbone, station, etc.) as it is completed.
2. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of the proposed test plan for each cable type including equipment to use used, set-up, test frequencies or wavelengths, results format, etc.
3. The Contractor shall visually inspect all cabling and termination points to insure that they are complete and conform to the wiring pattern defined herein. The contractor shall provide the Engineer with a written certification that this inspection has been made.
4. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner. Representatives of the Owner may be in attendance to witness the test procedures. The contractor shall provide a minimum of one (1) week advance notice to allow for such participation. The notification shall include a written description of the proposed conduct of the tests including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of Contractor involved. The Contractor shall ascertain that testing only as required to prove the wiring connections are correct.
6. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed.
7. All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the contractor. The applicable tests shall then be repeated.
8. Should it be found by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications

and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

B. Voice Cabling (Copper UTP)

1. Backbone Cabling

a. Backbone Voice cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity and conductor position on the termination blocks (e.g. 110). Any mis-positioned pairs shall be identified and corrected. The percentage of “bad” pairs shall not exceed 3% in any Backbone (Riser or Tie) Cable based on total pair count. All bad pairs must be identified and documented.

2. Station Cabling

a. Testing shall be from the Jack at the SIO voice outlet in the Work Area to the Termination Block on which the cables are terminated at the TC.
b. All horizontal “Station” cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, Wire Map (Conductor Position on the Modular Jack). Any defective, split or mis-positioned pairs must be identified and corrected.

C. Data Station Cabling (Copper UTP)

1. Testing shall be from the Jack at the SIO to the Data Patch Panel on which the cables are terminated at the wiring hub.
2. Horizontal “Station” cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on the Modular Jack). Any defective, split or mis-positioned pairs must be identified and corrected.
3. Testing of the Cabling Systems rated at TIA Category 5e and above shall be performed to confirm proper functioning and performance.
4. "In addition to the above , Performance Testing shall be performed on all cables. Testing of the Transmission Performance of station cables (Category 5e and above) shall include the following:

a. Length
b. Attenuation
c. Pair to Pair NEXT Loss (new limits)
d. PSNEXT Loss
e. Return Loss
f. Pair to Pair ELFEXT Loss (Equal Level Far End Cross-talk)
g. PSEFEXT Loss
h. Propagation Delay
i. Delay Skew
j. Return Loss

5. Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify "PASS" on each cable and display the

specified parameters - comparing test values with standards based "templates" integral to the unit.

6. Testing shall be per ANSI/TIA/EIA TSB67 Basic Link test configurations and ANSI/TIA/EIA 568-A-5 (SP 4195-A); Category 5e.
7. The maximum length of station cable shall not exceed 90 meters which allows 10 meters for equipment and patch cables. Worst case performance at 20°C, based on a Horizontal Cable length of 90 meters and Equipment Cord length of 4 meters, shall be as follows:

CATEGORY 5e (BASIC LINK)

| Frequency (MHz) | Attenuation (maximum dB) | NEXT Loss pair to pair (dB) | PS-NEXT Loss (dB; Worst Case) | ELFLEXT loss pair to pair (dB) | PSEFLEXT loss (dB) |
|---|---|---|---|---|---|
| 1.0 | 2.1 | 64.2 | 60.0 | 60.0 | 57.0 |
| 4.0 | 4.0 | 54.8 | 52.0 | 48.0 | 45.0 |
| 8.0 | 5.7 | 50.0 | 47.1 | 41.9 | 38.9 |
| 10.0 | 6.3 | 48.5 | 45.6 | 40.0 | 37.0 |
| 16.0 | 8.2 | 45.2 | 42.2 | 35.9 | 32.9 |
| 20.0 | 9.2 | 43.7 | 40.7 | 34.0 | 31.0 |
| 25.0 | 10.3 | 42.1 | 39.1 | 32.0 | 29.0 |
| 31.25 | 11.5 | 40.6 | 37.5 | 30.1 | 27.1 |
| 62.5 | 16.7 | 35.7 | 32.6 | 24.1 | 21.1 |
| 100.0 | 21.6 | 32.3 | 29.3 | 20.0 | 17.0 |

8. Propagation Delay

   a. The maximum propagation delay determined in accordance with the TIA/EIA -568-A-1 for a Basic Link configuration shall be less than 518-ns measured ad 10MHz. (Note: In determining the channel and basic link propagation delay, the propagation delay contribution of connecting hardware is assumed to not exceed 2.5 ns from 1 MHz to 100MHz.

9. Delay Skew

   a. The difference in propagation delay between the fastest and slowest pair in a cable shall not exceed the parameters below and the skew between all pair combinations shall not vary more than 610 ns when measured in accordance with TIA/EIA-568-A-1 and ASTM D 4566.

      - Category 5e 45ns between 1 MHz and 100MHz

10. Return Loss (Basic Link) Worst Pair

| Frequency | dB |
|---|---|
| 1-20 MHz | 17 |
| 20-100MHz | 17 - 7Log(f/20) |

   a. In order to establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an 8-position Category 5 Modular plug (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation

values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP data is available from the cable manufacturer for the exact cable type under test.

b. In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacement and changes as are necessary, and shall then repeat the test or tests which disclosed faulty or defective material, equipment or installation method, and shall make additional tests as the Engineer deems necessary at no additional expense to the project or user agency.

D. Documentation

1. General:

a. Upon completion of the installation, the contractor shall provide three (3) full Documentation Sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.

b. Documentation of Test Results shall be submitted in hard copy or in electronic form (preferred). Electronic documents may be submitted on CD-ROM (preferred) or 3½" diskettes for review and distribution. Where documentation provided in electronic form requires unique software (other than an MS-Word™ compatible Word Processor or MS-Excel™ spreadsheet) for viewing test results, the Contractor shall provide along with the above documentation, one (1) licensed copy of such software. The software shall run on a DOS or MICROSOFT *Windows*-based personal computer supplied by the Owner.

c. Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test result and *draft* as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.

d. The Engineer may request that a 10% random field re-test be conducted on the cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

2. Test Data - Copper Media

a. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

b. Printouts generated for each cable by the wire (or fiber) test instrument (e.g. *PentaScanner* or Optical Power Meter) shall be submitted as part of the documentation package. Alternately the contractor may furnish this information in electronic form (3.5" diskette).

3. Cross-Connect Data

a. As noted above, it shall be the responsibility of the Contractor to work with the Owner and Site Coordinator(s) and provide the necessary

assistance to allow Owner and/or Telephone Company personnel to make the necessary connections to establish telephone service on the new cable system. These activities include, but are not limited to (1) a general wiring overview and (2) detailed cross connect documentation (relating SIO I.D., Room Number and Riser pair). The latter shall be in the form of an electronic format database (dBase, MS Excel or convertible format).

4. As-built Construction Drawings

a. Drawings included with the specifications set shall be modified by the contractor to denote as-built information.
b. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.
c. The Owner through the Architect/Engineer will provide floor plans in electronic (".dwg", *AutoCAD* 2004) formats on which as-built construction information can be added. These documents will be modified accordingly by the contractor to denote as-built information as defined above.
d. The Contractors shall annotate the base drawings and return to the A/E in hard copy (same plot size as originals) and electronic (*AutoCAD* rel. 2004) form.
e. Each drawing submitted by the Contractor as part of the Project Documentation shall be identified as an "As-built" drawing and include the following (1) The Contractor name and/or logo (2) The date of the drawing.
f. All fonts, color, layer, Model Space/Paper Space conventions established in the base drawings shall be retained by the Contractor in preparation of the As-built drawings.

## 3.7 WARRANTY

A. This Contractor shall guarantee all materials, equipment, etc., two (2) years from date of substantial completion of this work. In the case of data cabling the contractor shall furnish complete Category 5E system warranty consisting of no less than fifteen (15) years. This guarantee shall include all labor, material and travel time. See Division 1, GENERAL CONDITIONS, and GENERAL REQUIREMENTS - Guarantee Documents for further requirements.

**END OF SECTION**

## SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

### PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS

A. Applicable requirements of Division 1 shall govern work in this section.

### 1.2 SCOPE

A. Provide rough in for communications outlets consisting of outlet boxes, conduits, surface raceway, sleeves and communication backboards.

### 1.3 RELATED WORK

A. Section 26 05 33 – Raceway and Boxes for Electrical Systems

### 1.4 DESCRIPTION

A. Provide an empty raceway system for data, telephone and television communications cabling as directed. All conduits shall be complete with fish wire by Electrical Contractor.

B. Outlet boxes, terminal cabinets, plywood backboards and conduits for communications outlets shall be provided under this contract.

C. Data, telephone and television instruments, switching equipment, cabling, terminal blocks and other accessories are provided by Owner.

### PART 2 – PRODUCTS

### 2.1 EQUIPMENT

A. Concealed outlet boxes shall be 4-11/16” square, 2-1/8” deep with extension ring for a one gang device. Covers shall be full sized blank plastic plates.

B. Surface outlet boxes and cover shall be part of surface raceway as specified in Section 26 05 33.

### PART 3 – EXECUTION

### 3.1 GENERAL

A. Provide a ¾“ empty conduit from each concealed outlet to the nearest accessible corridor ceiling cavity space or underfloor duct system. Provide bushings at corridor end of each conduit.

B. Provide surface raceway, as specified in Section 26 05 33, for each surface mounted outlet. Surface raceway shall extend up to above finished ceiling elevation. Transition to a ¾” empty conduit from surface raceway to nearest accessible corridor ceiling cavity space and/or cable tray. Provide bushings at corridor end of conduit.

C. Provide blank covers over all unused system outlet boxes.

END OF SECTION

## SECTION 28 31 00 - FIRE DETECTION AND ALARM

## PART 1 – GENERAL

### 1.1 DESCRIPTION

A. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators and wiring as shown on the drawings and specified herein.

B. The fire alarm system shall comply with requirements of 2002 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

C. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

D. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).

E. The system and its components shall be Underwriters Laboratories, Inc. listed as a complete system under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

F. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final check-out and to ensure the systems integrity.

### 1.2 SCOPE

A. A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.

B. Basic Performance:

1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
2. Initiation Device Circuits (IDC) shall be wired Class B (NFPA Style B) as part of an addressable device connected by the SLC Circuit.
3. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Y) as part of an addressable device connected by the SLC Circuit.
4. Digitized electronic signals shall employ check digits or multiple polling.
5. A single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
6. Alarm signals arriving at the main FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

7. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone which ever is greater.
8. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
9. NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.
10. Two-way telephone communication circuits shall be supervised for open and short circuit conditions.

C. BASIC SYSTEM FUNCTIONAL OPERATION

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur.

1. The system alarm LED on the FACP shall flash.
2. A local piezo electric signal in the control panel shall sound.
3. A backlit 80-character LCD display on the FACP shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
4. Printing on the remote printer and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

**D. Fire alarm plan submission:**

**1. The contractor and fire alarm system supplier shall prepare necessary sets of plans and forms of the fire alarm system for approval by the Wisconsin Department of Commerce (DOC) and Authority Having Jurisdiction (AHJ) prior to construction. Submittal requirements include:**

**a. Battery calculations.**
**b. Voltage drop calculations for all circuit runs.**
**c. Device information including coverage area of detectors, visual and audio ratings, etc.**
**d. Locations of all devices. Additional devices as needed to meet all code requirements shall be included in bid to meet all applicable codes (additional devices beyond those shown on the plans that are identified by Engineer during shop drawing review and/or as determined by the AHJ/DOC approval process will not be paid as a change order).**

**e. Complete list of detection, evacuation signaling and annunciator zones and/or addresses.**

**f. Complete list of fire control functions (i.e. fan shut down, etc.).**

**g. Complete sequence of operations, detailing all inputs and outputs.**

**h. All other information required for review and approval.**

**i. Floor plans.**

**2. Plans and forms will be stamped and signed by the Engineer prior to submittal if necessary.**

**3. The contractor and/or fire alarm supplier shall submit all stamped plans and forms, and payment to the appropriate authorities.**

**4. The contractor shall apply for the permit from the appropriate AHJ and include all work related and necessary in the bid.**

**1.3 SUBMITTALS**

A. General:

1. Six copies of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
3. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance and quality of the specified equipment.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams and conduit layouts.
3. Show annunciator layout, configurations and terminations.

C. Manuals:

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

D. Software:

1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

E. Certifications:

1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

## 1.4 GUARANTY

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

## 1.5 APPLICABLE STANDARDS AND SPECIFICATIONS

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

A. National Fire Protection Association (NFPA) - USA:

| | |
|---|---|
| No. 12 | CO2 Extinguishing Systems (low and high) |
| No. 12B | Halon 1211 Extinguishing Systems |
| No. 13 | Sprinkler Systems |
| No. 13A | Halon 1301 Extinguishing Systems |
| No. 15 | Water Spray Systems |
| No. 16 | Foam/Water Deluge and Spray Systems |
| No. 17 | Dry Chemical Extinguishing Systems |
| No. 17A | Wet Chemical Extinguishing Systems |
| | Clean Agent Extinguishing Systems |
| No. 72-1999 | National Fire Alarm Code |
| No. 101 | Life Safety Code |

B. Underwriters Laboratories, Inc. (UL) - USA:

| | |
|---|---|
| No. 268 | Smoke Detectors for Fire Protective Signaling Systems |
| No. 864 | Control Units for Fire Protective Signaling Systems |
| No. 268A | Smoke Detectors for Duct Applications |
| No. 521 | Heat Detectors for Fire Protective Signaling Systems |

| | |
|---|---|
| No. 464 | Audible Signaling Appliances |
| No. 38 | Manually Actuated Signaling Boxes |
| No. 346 | Waterflow Indicators for Fire Protective Signaling Systems |
| No. 1076 | Control Units for Burglar Alarm Proprietary Protective Signaling Systems |
| No. 1971 | Visual Notification Appliances |

C. Local and State Building Codes.

D. All requirements of the Authority Having Jurisdiction (AHJ).

E. The Video Display Terminal (VDT) shall comply with Swedish magnetic emission and X-radiation guidelines MPR 1990:10.

## 1.6 APPROVALS

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories, Inc.

FM Factory Mutual

B. The fire alarm control panel shall meet UL Standard 864 (Control Units) and UL Standard 1076 (Proprietary Burglar Alarm Systems).

C. The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low pressure CO2.

## 1.7 ACCEPTABLE MANUFACTURERS

A. Simplex (Expand existing system)

# PART 2 – PRODUCTS

## 2.1 EQUIPMENT AND MATERIAL, GENERAL

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

B. All equipment and components shall be installed in strict compliance with manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

C. All equipment back boxes shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g. detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

## 2.2 CONDUIT AND WIRE

A. Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. All wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent or interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.

B. Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable shall have a fire resistance rating suitable for the installation as indicated in NFPA 70.
5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. In certain applications, the system shall support up to two (2) SLC's with up to 1,000 feet of untwisted, unshielded wire. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
6. All field wiring shall be electrically supervised for open circuit and ground fault.
7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLC's). Systems which do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.

C. Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

## 2.3 MAIN FIRE ALARM CONTROL PANEL

A. The FACP shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system; intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators and other system controlled devices.

B. Operator Control

1. Acknowledge Switch:

   a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
   b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

2. Alarm Silence Switch:

   a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

3. Alarm Activate (Drill) Switch:

   a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4. System Rest Switch:

   a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

5. Lamp Test:

   a. The Lamp Test switch shall activate all system LEDs and light each segment of the liquid crystal display.

C. System Capacity and General Operation

1. The control panel shall provide a minimum of 20% spare capacity for intelligent/addressable devices.
2. The control panel shall include Form-C alarm, trouble, supervisory and security relays rated at a minimum of 3.0 amps @ 30 VDC. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits.
3. The system shall support up to 8 additional output modules (signal, speaker, telephone or relay), each with 8 circuits for an additional 64 circuits. These shall be either Class A (NFPA Style D) or Class B (NFPA Style Y) per the project drawings.
4. The fire alarm control panel shall include a full-featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color-coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
5. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel. The system shall be fully programmable, configurable and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
6. They system shall allow the programming of any input to activate any output or group of outputs. Systems which have limited programming (such as general alarm), have complicated programming (such as a diode matrix).
7. The FACP shall provide the following features:

    a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.

    b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.

    c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.

    d. Nine sensitivity levels for alarm, selected by detector. The alarm level range shall be 1 to 2.35 percent per foot for photoelectric detectors and 0.5 to 2.5 percent per foot for ionization detectors. The system shall also include up to nine levels of pre-alarm, selected by detector, to indicate to maintenance personnel of impending alarms.

    e. The ability to display or print system reports.

    f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.

    g. PAS pre-signal, meeting NFPA 72 3-8.3 requirements.

h. Rapid manual station reporting (under 3 seconds).

i. Non-alarm points for general (non-fire) control.

j. Periodic detector test, conducted automatically by the software.

k. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.

l. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.

m. Walk test, with a check for two detectors set to same address.

n. Control-by-time for non-fire operations, with holiday schedules.

o. Day/night automatic adjustment of detector sensitivity.

p. Device blink control for sleeping areas.

q. UL-1076 security monitor points.

r. Releasing options including: 10 independent hazards, a sophisticated cross zone, delay and discharge timers, and an abort function. The system shall also include the ability to control low pressure CO2 valves with the ability to set time in/time out values in one second increments including a soak time of up to 9999 seconds.

8. The FACP shall be capable of coding notification circuits in march time (120 PPM), and temporal (NFPA 72 A-2-2.2.2). Main panel notification circuits (NAC 1, 2, 3 and 4) shall also support special two and three stage operations. The two stage feature allows 20 Pulses Per Minute (PPM) on alarm and 120 PPM after 5 minutes or when a second device activates. The three stage option provides 20 PPM with one detector in alarm, 120 PPM with two detectors in alarm and steady on with release.

D. Central Microprocessor

1. The microprocessor shall be a state-of-the-art, high speed, and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, non-volatile memory for building-specific program storage and a “watch dog” timer circuit to detect and report microprocessor failure.
2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory and shall not be lost even if system primary and secondary power failure occurs.
3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week and day-of-year.

4. A special program check function shall be provided to detect common operator errors.
5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
6. For flexibility and to ensure program validity, an optional Windows™ based program utility shall be available. This program shall be used to off-line program the system with batch upload/download. This program shall also have a verification utility which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

E. Display

1. The display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits and software zones.
3. The display shall include an 80-character back-lit alphanumeric Liquid Crystal Display (LCD). It shall also provide 8 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PRE-ALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, and ALARM SILENCED.
4. The display shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
5. The display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET and LAMP TEST.
6. The system shall support an optional battery ammeter/voltmeter display.

F. Signaling Line Circuits (SLC)

1. The system shall include a minimum of 20% spare capacity in the SLCs. Provide quantity as needed. Each SLC interface shall provide power to and communicate with up to 127 addressable devices. Each SLC shall be capable of NFPA 72 Style 4, (Class B) wiring.
2. The Loop Interface Board (LIB) shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, pre-alarm or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
3. The detector software shall meet NFPA 72, Chapter 7 requirements and be certified by UL as a calibrated sensitivity test instrument.

4. The detector software shall allow manual or automatic sensitivity adjustment.

G. Serial Interfaces

1. The system shall include two serial EIA-323 interfaces. Each interface shall be a means of connecting UL Listed Electronic Data Processing (EDP) peripherals.
2. One EIA-232 interface shall be used to connect an UL-Listed 80 column printer. Printers which are not UL-Listed are not considered acceptable substitutes.
3. The second EIA-232 interface shall be used to connect an UL-listed CRT terminal. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.
4. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
5. The EIA-485 interface may be used for network connection to a proprietary receiving unit.

H. Notification Appliance Circuit (NAC) Module

1. The Notification Appliance Circuit module shall provide fully supervised Class B (NPFA Style Y) notification circuits. An expansion circuit board shall allow expansion to eight circuits per module.
2. The notification circuit capacity shall be 2.0 amperes maximum per circuit and 8.0 amperes maximum per module.
3. The module shall not affect other module circuits in any way during a short circuit condition.
4. Each notification circuit shall include a custom label inserted to identify each circuit's location. Labels shall be created using a standard typewriter or wordprocessor.
5. The notification circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.
6. Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.

I. Control Relay Module

1. The control relay module shall provide four Form-C auxiliary relay circuits rated at 5 amperes, 28 VDC. An expansion circuit board shall allow expansion to eight Form-C relays per module.
2. Each relay circuit shall be capable of being activated (change in state) by any initiating device or form any combination of initiating devices.
3. Each relay circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or wordprocessor.
4. The control relay module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal blocks shall be UL listed for use with up to 12 AWG wire.

J. Voice Control Module (speakers)

1. The voice control (speaker circuit) module shall provide four fully supervised Class B (NFPA Style Y) or Class A (NFPA Style Z) NAC speaker circuits. An expansion circuit board shall allow expansion for up to eight circuits per module.
2. Each speaker circuit shall be capable of switching up to 30 watts maximum per circuit or 60 watts per four circuit module.
3. If a short-circuit trouble occurs on one of the circuits, that will not activate on either manual or automatic command.
4. The module shall provide green ON/OFF LEDs and yellow TROUBLE LEDs.
5. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
6. Each voice circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or wordprocessor.
7. The voice control module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL Listed for use with up to 12 AWG wire.
8. Each speaker circuit module may be programmed to activate on activation of the All-Call switch and to deactivate upon pressing the signal silence switch.

K. Voice Control Module (Telephone)

1. The voice control module (telephone) shall provide four fully supervised Class B (NFPA Style Y) or Class A (NFPA Style Z) telephone circuits. An expansion circuit board shall allow expansion to eight circuits per module.
2. The system shall allow a minimum of seven (7) telephones connected simultaneously to the telephone bus at a given time.
3. If a short-circuit trouble occurs on one of the telephone circuits, that circuit will not activate on manual command.
4. The module shall provide eight green ON/OFF/CALL-IN LEDs and eight yellow TROUBLE LEDs. These LEDs will indicate the status of the individual circuits.
5. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular telephone circuit on or off or to disable the circuit.
6. Each telephone circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or wordprocessor.
7. The telephone module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL-listed for use with up to 12 AWG wire.
8. Telephone circuits shall have a visual indication by zone that a call-in is taking place and have a unique call-in tone.

L. Voice Command Center (VCC)

The Voice Command Center (VCC) shall contain equipment required for all audio control, telephone system control, signaling and supervisory functions. This shall include amplifiers, tone generators, digital voice units, a microphone and a main telephone handset. The voice command center shall be an integral part of the

fire alarm system. Systems which require separate, non-integrated voice systems are not considered suitable substitutes.

Function: The voice command center equipment shall perform the following functions:

1. Operate as a supervised single channel or dual channel emergency voice communication system.

2. Provide automatic custom digital recorded voice message and tone generation.
3. Provide a hand held microphone with priority push-to-talk switch.
4. Provide an all-call switch and indicator to quickly activate all speaker circuits.
5. Operate as a two-way emergency telephone system control center.

M. Enclosures:

1. The control panel shall be housed in an UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be selected for either right or left hand hinging.

N. Power Supply:

1. The main power supply for the fire alarm control panel shall provide 6.0 amps of available power for the control panel and peripheral devices.
2. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 50 AH or may be used with an external battery and charger systems. Battery arrangement may be configured in the field.
4. The main power supply shall continuously monitor all field wires for earth ground conditions and shall have the following LED indicators:

   Ground Fault LED
   Battery Fail LED
   AC Power Fail LED

5. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.
6. The main power supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge.
7. The main power supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
8. All circuits shall be power-limited, per 1995 UL864 requirements.

O. Field Charging Power Supply: The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.

1. The FCPS shall offer up to 8.0 amps (4.0 amps continuous) of regulated 24-volt power. It shall include an integral charger designed to charge 12.0 amp hour batteries and to support 24-hour standby.
2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (Style Y) shall be available for connection to the Notification devices.

3. The FCPS shall include an attractive surface mount backbox.
4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per 1993 NFPA requirements.
5. The FCPS include power limited circuitry, per 1995 UL standards.
6. EC to provide 120 volt circuits as determined from supplier.

P. Audio Amplifiers:

1. The audio amplifiers will provide audio power (@ 25 Volts RMS) for distribution to the speaker circuits.
2. Multiple audio amplifiers may be mounted in the fire alarm control panel using additional cabinets if necessary.
3. The audio amplifiers shall include an integral power supply, and shall provide the following controls and indicators:

   Normal Audio Level LED
   Incorrect Audio Level LED
   Brownout LED
   Battery Trouble LED
   Amplifier Trouble LED
   Audio Amplifier Gain Adjust

4. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
5. All terminal blocks for the connection of field wiring shall have a removable plug-in and be hardwired to allow for ease of field wire installation in a cabinet or at a remote location.
6. The amplifier shall include audio input and amplified output supervision, back up input and automatic switch over to back up (if primary amplifier should fail).
7. Amplifiers shall be backed up in groups (one amplifier backs up several primary amplifiers).

Q. Pre-recorded Voice - Audio Message Generator

1. The voice communication system shall be capable of transmitting a pre-recorded voice message to all speakers in the building or to any programmed group of speakers.
2. Actuation of any alarm initiating device shall cause a pre-recorded message to sound over the speakers. The message shall be repeated four times.
3. A built-in microphone shall be provided to allow paging through speaker circuits and shall have priority over the alarm message.
4. The message generator shall provide an interface to allow paging through telephone circuits.
5. The audio message generator shall have the following controls and indicators to allow for proper operator understanding and control.

Audio Level Normal LED
All Call LED
On-Line LED
Amplifier Trouble LED
Speaker Trouble LED
All Call Switch
Local Speaker Volume Control

6. The pre-recorded message shall be stored on a non-volatile read only memory chip. The message shall be up to 24 seconds in length. An optional random access chip shall be available for a field programmable message. This message shall be programmed through the system's microphone or downloaded via a cassette recorder. Systems which utilize pre-recorded memory storage other than on ROM type memory chips are not suitable substitutes.

R. Specific System Operations

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enable to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
4. Point Read: The system shall be able to display or print the following point status diagnostic functions:

   a. Device status
   b. Device type
   c. Custom device label
   d. View analog detector values
   e. Device zone assignments
   f. All program parameters

5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 600 events. Up to 300 events shall be dedicated to alarm and the remaining events are supervisory. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time or printed in its entirety.

   The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.

7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
8. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
9. Software Zones: The FACP shall provide 99 software zones and 10 additional special function zones.
10. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:

    a. Alarm an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.

    b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.

    c. Walk test shall be selectable on a per device/circuit basis. All devices and circuits which are not selected for walk test shall continue to provide fire protection and if an alarm is detected, will exit walk test and activate all programmed alarm functions.
    d. All devices tested in walk test shall be recorded in the history buffer.

11. Waterflow Operation

    An alarm from a waterflow detection device shall activate the appropriate alarm message on the 80-character display, turn on al programmed notification appliance circuits and shall not be affected by the signal silence switch.

12. Supervisory Operation

    An alarm from a supervisory device shall cause the appropriate indication on the 80-character display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

13. Signal Silence Operation

    The FACP shall have the ability to program each output circuit (notification, relay, speaker, etc.) to deactivate upon depression of the signal silence switch.

14. Non-Alarm Input Operation

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally-open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

15. Combo Zone

A special type code shall be available to allow waterflow and supervisory devices to shall a common addressable module. Waterflow devices shall be wired in parallel, supervisory devices in series.

## 2.4 SYSTEMS COMPONENTS

A. Speakers and/or strobes:
1. Units shall be low profile.
2. All speakers shall operate on 25 or 70.7 VRMS with 1/8W, 1/4W, 1/2W, 1W, 2W, 4W. field selectable output taps.
3. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).
4. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
5. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.
6. Strobes shall have a maximum pulse duration of 2/10 of one second. The flash rate and strobe intensity shall meet the requirements of UL 1971 and be synchronized.
7. Indoor wall mounted strobes shall have multi-selectable candela settings of 15, 30, 60, 75, and 110. Indoor ceiling mounted strobes shall have multi-selectable candela settings of 15, 30, 75, 95, and 115. Exterior strobes shall have a candela rating of 75.
8. Shall be flush mounted in public areas.
9. Verify color with Architect and AHJ.

B. Waterflow Indicator:

1. Waterflow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.
2. Waterflow Switches shall have an alarm transmission delay.
3. All waterflow switches shall come from a single manufacturer and series.
4. Waterflow switches shall be furnished and installted by the sprinkler contractor and wired by the electrical contractor.

C. Sprinkler and Standpipe Valve Supervisory Switches:

1. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.
3. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stern has moved no more than one-fifth of the distance from its normal position.

4. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a ¾ inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The switch housing shall be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be furnished and installed by the sprinkler contractor and wired by the electrical contractor.

D. Fixed Emergency Telephone Handset

1. The telephone cabinet shall be painted red and clearly labeled as "Emergency Telephone." The cabinets shall be located where shown on drawings.
2. The handset cradle shall have a switch connection so that lifting the handset off of the cradle shall send a signal to the fire command center which shall audibly and visually indicate its on-line (off-hook) condition.
3. On activating the remote phone, the phone earpiece shall sound a telephone ring signal until the master handset is lifted.
4. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.

E. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.

F. Stand Alone Voice Evacuation Control Panel

1. A stand alone Voice Evacuation Control Panel shall be available from the same manufacturer of the main fire alarm system.
2. This Voice Control Panel shall work stand alone or as a slave to the Main Control Panel.
3. Shall have as minimum requirements:
   a. Integral 25 Watt, 25 Vrms audio amplifier.
   b. Speaker circuit that can be wired both Class A or B.
   c. Integral Digital Message Generator with a capacity of up to 60 seconds. The Digital Message Generator shall be capable of primary and secondary messages (30 seconds each). These messages shall field programmable without the use of additional equipment.
   d. Built in alert tone generators with steady, slow woop, high/low and chime tone field programmable.
   e. Integral Diagnostic LEDs for Power, System Trouble, Message Generator Trouble, Tone Generator Trouble and Alarm.

4. The Voice Control Panel shall be fully supervised including microphone, amplifier output, message generator, speaker wiring and tone generators.

5. Speaker outputs shall be fully power-limited.

G. Field Wiring Terminal Blocks

For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks which are permanently fixed are not acceptable.

## 2.5 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

A. Addressable Devices - General

1. Addressable devices shall used simple to install and maintain decade (numbered 0 to 9) type address switches.
2. Addressable devices will use a binary-coded address setting method, such as a DIP switch.
3. Detectors shall be intelligent (analog) and addressable and shall connect with two wires to the fire alarm control panel signaling line circuits.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-timed measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.

13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

B. Addressable Pull Box (manual station)

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual stations shall be double action, non-breakglass, constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44mm) or larger. They shall be of modern design appearance.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

D. Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.

2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

3. A remote indicator/test station shall be provided for each duct detector (regardless if shown or not on the plans). The location shall in a visible location in the room or ceiling and have an engraved plaque identifying the location of the detector (i.e. RTU-2 Return).

E. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. The IDC zone shall be suitable for Style D or Style B operation. A LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x ½ inch (12.7 mm). This version need not include Style D or an LED.

F. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall mount in a standard 4-inch (101.6 mm) deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

## 2.6 BATTERIES

A. The batteries shall be sealed Gel Cell type, 12 volt nominal.

B. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 15 minutes of alarm upon a normal AC power failure.

C. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills and leakage shall not be required.

D. If necessary to met standby requirements, external battery and charger systems may be used.

# PART 3 – EXECUTION

## 3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. Manual pull stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

## 3.2 TEST

The service of competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity and insulation.
2. Waterflow and tamperswitches shall be tested along with the sprinkler contractor.
3. Open initiating device circuits and verify that the trouble signal actuates.
4. Open and sort signaling line circuits and verify that the trouble signal actuates.
5. Open and short notification appliance circuits and verify that trouble signal actuates.
6. Ground all circuits and verify response of trouble signals.
7. Check presence and audibility of tone at all alarm notification devices.
8. Check installation, supervision and operation of all intelligent smoke detectors using the walk test.
9. Each of the alarm conditions that the system is required to detect should 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 points.
10. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying control performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

## 3.3 FINAL INSPECTION

A. At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

## 3.4 INSTRUCTION

A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

END OF SECTION