City of Milwaukee

Department of Public Works

Infrastructure Services Division

Bridges and Buildings Section

7TH DISTRICT POLICE STATION
RTUs REPLACEMENT

3626 West Fond du Lac Avenue
Milwaukee, WI 53216-3739

January, 2016

Project Number PL120130100
Official Notice No. 16-1-2016

CITY OF MILWAUKEE, WISCONSIN

DEPARTMENT OF PUBLIC WORKS

INFRASTRUCTURE SERVICES DIVISION

BRIDGES AND BUILDINGS SECTION

PROJECT MANUAL

GOVERNING THE

7TH DISTRICT POLICE STATION

RTUs REPLACEMENT

3626 WEST FOND DU LAC AVENUE

MILWAUKEE, WI 53216-3739

Project No. **PL120130100**

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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: MARTIN MATSON,
City Comptroller

CITY OF MILWAUKEE
SPECIFIC OFFICIAL NOTICE NO. 16-1-2016

Sealed bids will be opened on **Tuesday, March 1, 2016 at 10:30 A.M**. for the **7TH DISTRICT POLICE STATION, RTUs REPLACEMENT**, **located at 3626 West Fond Du Lac Avenue, Milwaukee WI.**

IMPORTANT NOTICE: The Invitation to Bid, all bid documents and the Plans and Specifications for the listed project(s) are all available electronically on the DPW website AS WELL AS **on the Bid Express Website**. At this time, Bids can be submitted using either Bid Express OR by purchasing and submitting paper bids in the usual manner. However, Bidders are strongly encouraged to utilize the electronic and/or Bid Express methods of obtaining bid documents and Bid Express for submitting bids, as in the near future the Department of Public Works intends to have bid documents available only electronically and through Bid Express, *and to accept bid submittals only via Bid Express.*

Electronic documents can be obtained via http://www.mpw.net/bids/docs/16-2016. The Bid Express website is located at bidexpress.com. Any required addenda or response related to listed projects will be posted on both the DPW and Bid Express websites. At this time there are still a limited number of hard copies of the bid documents available at the address listed below. IF YOU ONLY PRINT THE DOCUMENTS THE DPW WEBSITE PLEASE CALL 414-286-3314 TO HAVE YOUR COMPANY'S NAME AND CONTACT INFORMATION PLACED ON THE PAN HOLDER'S LIST.

Pre-Bid Meeting: A Pre-Bid Meeting is scheduled for **Tuesday, February 16, 2016 at 10:00am** in the 7th District Police Station, 3626 West Fond Du Lac Avenue (Check in at lobby, front desk), Milwaukee, Wisconsin. Bidder participation is required to become familiar with all aspects of the project and bidding requirements.

Bid Security Required: Bond (either Electronic thru Bid Express or Paper), Certified Check, Cashier's Check or Cash to accompany bid: 10% of the Contractor's Base Bid. For those bids being submitted through BID EXPRESS and using a Paper Bond, the contractor may fax a signed/executed copy of the bid bond to the Department of Public Works Contract Office at 414-286-8110. **HOWEVER, THE FAXED COPY OF THE BOND MUST BE RECEIVED BY NO LATER THAN 10:30 A.M. ON THE SAME DATE THAT THE BIDS ARE DUE FOR THAT SPECIFIC OFFICIAL NOTICE, or the bid will be considered non-responsive.** *The original bid bond document will then need to be submitted by the contractor to the Department of Public Works Contract Office, Rm. 506, Municipal Building, immediately upon being notified that they are the apparent low bidder*

Time for Completion: 60 Working Days

Liquidated Damages, per diem: $150.00

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

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

The residency requirement for this project is 40% of all hours worked on the project.

The apprenticeship requirements for this project are: **1**

GENERAL LABORER, SHEETMETAL WORKER

The contractor shall specifically note the SBE, residency, and apprenticeship forms for this project. If the forms are

not filled out properly, it will be cause for rejection of the bid.

PAYMENT MONITORING REQUIREMENTS

All Contractors awarded a contract valued at $25,000.00 or more are required to participate in training on the City of Milwaukee's B2GNow contract compliance software. Contractors must complete the training no later than 30 days after the date of contract award. Throughout the contract term, Contractors are required to regularly provide timely payment information in the City's contract compliance software.

Please contact the Office of Small Business Development (OSBD) at 414-286-5553 should you have any questions or concerns regarding the training or *reporting process.*

PAYROLL MONITORING REQUIREMENTS: The Prime Contractor awarded this project is required to participate in training on the City of Milwaukee's LCP Tracker Labor Compliance Software after the date of contract award. Throughout the contract term, Contractors are required to regularly provide timely payroll information via LCP Tracker.

Please contact the DPW Contracts Office at 414-286-3314 should you have any questions or concerns regarding the training or reporting process.

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

Signed:

_____
GHASSAN KORBAN
Commissioner of Public Works.

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 BIDS:

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

Alternate No. 1:

State the amount to be **added** to the Base Bid to perform all work and furnish all materials for the following items as denoted below:

VAV Retrofit

a. Provide new VAV boxes with electric reheat coils and electric heating coils in the existing supply air ductwork distribution system. Provide modifications to the existing ductwork to accommodate the installation of the new VAV boxes and heating coils.

b. Provide new transfer air ductwork and grilles. Provide new supply and return ductwork for rooms that are presently not conditioned.

c. Provide direct digital controls for the new VAV boxes and reheat coils and interface with the existing Trane Tracer system (BCU).

Alternate No. 2:

State the amount to be **added** to the Base Bid to perform all work and furnish all materials for the following items as denoted below:

Replace Garage HV

a. Provide a new gas–fired heating and ventilating unit for the Garage to replace the existing heating and ventilating unit. Provide new ductwork, gas piping, and controls associated with the new unit. New garage unit and associated gas detection and ventilation shall be connected and integrated into existing Trane BCU controller.

b. Provide demolition of the existing heating and ventilating unit.

Alternate No. 3:

State the amount to be **added** to the Base Bid to perform all work and furnish all materials for the following items as denoted below:

Replace PRV Fans

a. Provide new roof-mounted exhaust fans for the Garage and the Restrooms including associated controls.

Alternate No. 4:

State the amount to be **added** to the Base Bid to perform all work and furnish all materials for the following items as denoted below:

Replace Controls Head End

a. Replace existing Trane Tracer BCU with bridge, SE controller and Ethernet switch. All existing equipment on the BCU shall be migrated into the new SE controller and provided with new graphics interface at the Police Administration Building (4 PCs).

Alternate No. 5:

State the amount to be **added** to the Base Bid to perform all work and furnish all materials for the following items as denoted below:

Replace Duct Smoke Detectors

a. Replace existing duct smoke detectors in exhaust duct from each holding cell with new ionization type duct smoke detectors. Include sampling tube, remote testing station and HVAC equipment shutdown interlock to new HVAC equipment (starter, VFD, etc.).

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 Additive Alternate(s) as selected, and 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 should visit the site, consult the drawings and project manual, be familiar with the work of other contractors and determine for themselves all conditions affecting the work.

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.

TIME FOR COMPLETION:

The time for completion is stated in the Specific Official Notice. The contractor may begin procuring materials

and off-site fabricating (as appropriate and approved by engineer) 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:

Testing and balancing by others under a separate contract with the City.

All Electrical work is to be performed by the City with the exception of HVAC Control wiring.

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.

PAYMENT MONITORING REQUIREMENTS

All Contractors awarded a contract valued at $25,000.00 or more are required to participate in training on the City of Milwaukee's B2GNow contract compliance software. Contractors must complete the training no later than 30 days after the date of contract award. Throughout the contract term, Contractors are required to regularly provide timely payment information in the City's contract compliance software.

Please contact the Office of Small Business Development (OSBD) at 414-286-5553 should you have any questions or concerns regarding the training or *reporting process.*

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 BRIDGES AND BUILDINGS SECTION, Room 602, Zeidler Municipal Building.

3. Definitions:

   A. Owner: City of Milwaukee.

   B. Facilities Operations Manager: The Facilities Operations Manager of BRIDGES AND BUILDINGS SECTION.

   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 and/or Section 00870 Plans and Details.

   F. Utility: WE Energies.

   G. End User: City of Milwaukee.

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 Operations Manager. Prints shall be the same size as contract documents when practical. Prints of each drawing shall be submitted to the Facilities Operations Manager for approval before proceeding with the work. Changes ordered by the Facilities Operations Manager shall be made and revised prints submitted as above. The Facilities Operations 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 transfer 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 Operations 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 BRIDGES AND BUILDINGS SECTION 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 standards.

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: 1/8/2016

DETERMINATION NUMBER: 201600002

EXPIRATION DATE: Prime Contracts MUST Be Awarded or Negotiated On Or Before 12/31/2016. 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: - over 10 hours per day on prevailing wage projects - over 40 hours per calendar week - Saturday and Sunday - 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; - The day before if January 1, July 4 or December 25 falls on a Saturday; - The day following if January 1, July 4 or December 25 falls on a Sunday. 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. 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.

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 Future Increase(s): Add $1.65/hr on 6/1/2016.	35.28	20.96	56.24
102	Boilermaker	30.21	21.97	52.18
103	Bricklayer, Blocklayer or Stonemason Future Increase(s): Add $1.45 on 06/06/2016 Premium Increase(s): 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.	36.74	19.26	56.00
104	Cabinet Installer Future Increase(s): Add $1.65/hr on 6/1/2016.	35.28	20.96	56.24
105	Carpenter Future Increase(s): Add $1.65/hr on 6/1/2016. Premium Increase(s): 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.	35.28	20.96	56.24
106	Carpet Layer or Soft Floor Coverer Future Increase(s): Add $1.65/hr on 6/1/2016.	35.28	20.96	56.24
107	Cement Finisher Future Increase(s): Add $1.45 on 05/31/2016	32.88	19.88	52.76
108	Drywall Taper or Finisher Future Increase(s): Add $1.00/hr eff. 06/01/2016; Add $1.05/hr eff. 06/01/2017	30.42	21.19	51.61
109	Electrician Future Increase(s): Add $1.60 on 6/1/16; Add $1.70 on 6/1/17 Premium Increase(s): 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.	35.13	23.19	58.32

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
110	Elevator Constructor	43.84	27.09	70.93
111	Fence Erector	24.73	19.69	44.42
112	Fire Sprinkler Fitter	39.66	21.11	60.77
113	Glazier Future Increase(s): Add $.90/hr eff. 06/01/2016	34.45	18.99	53.44
114	Heat or Frost Insulator	33.53	27.31	60.84
115	Insulator (Batt or Blown)	23.62	11.55	35.17
116	Ironworker	30.77	23.72	54.49
117	Lather	34.13	20.61	54.74
118	Line Constructor (Electrical)	40.81	18.06	58.87
119	Marble Finisher	25.72	18.54	44.26
120	Marble Mason	35.89	18.77	54.66
121	Metal Building Erector	19.00	2.00	21.00
122	Millwright Future Increase(s): Add $1.35/hr on 6/1/2016.	29.78	26.38	56.16
123	Overhead Door Installer	28.73	0.00	28.73
124	Painter Future Increase(s): Add $1.00/hr on 06/01/2016; Add $1.05/hr on 06/01/2017 Premium Increase(s): 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.	30.07	21.19	51.26
125	Pavement Marking Operator	30.00	19.61	49.61
126	Piledriver Future Increase(s): Add $1.60/hr on 6/1/2016. Premium Increase(s): 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.	30.58	27.54	58.12
127	Pipeline Fuser or Welder (Gas or Utility)	41.01	21.54	62.55
129	Plasterer	30.22	20.53	50.75

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
130	Plumber Future Increase(s): Add $2/hr on 6/1/16; Add $2/hr on 6/1/17.	39.62	20.12	59.74
132	Refrigeration Mechanic Future Increase(s): Add $2.00 on 6/1/16; Add $2.00 on 6/1/17	42.36	21.99	64.35
133	Roofer or Waterproofer	29.65	18.61	48.26
134	Sheet Metal Worker	37.91	21.05	58.96
135	Steamfitter Future Increase(s): Add $2.00 on 6/1/16; Add $2.00 on 6/1/17	42.36	21.99	64.35
137	Teledata Technician or Installer Premium Increase(s): 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.	26.00	17.74	43.74
138	Temperature Control Installer	41.01	21.54	62.55
139	Terrazzo Finisher	25.72	18.54	44.26
140	Terrazzo Mechanic Future Increase(s): Add $1.45 on 06/06/2016	31.59	19.60	51.19
141	Tile Finisher	30.00	0.00	30.00
142	Tile Setter	30.18	17.34	47.52
143	Tuckpointer, Caulker or Cleaner	34.28	18.60	52.88
144	Underwater Diver (Except on Great Lakes)	36.74	16.00	52.74
146	Well Driller or Pump Installer Future Increase(s): Add $1/hr on 6/1/2016; Add $1/hr on 6/1/2017.	25.32	16.40	41.72
147	Siding Installer	17.00	6.71	23.71
150	Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	36.73	20.41	57.14
151	Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	32.65	14.96	47.61
152	Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	28.57	13.71	42.28
153	Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	26.53	13.55	40.08
154	Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	25.00	12.55	37.55

TRUCK DRIVERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
201	Single Axle or Two Axle	34.47	18.70	53.17
203	Three or More Axle	20.00	18.19	38.19
204	Articulated, Euclid, Dumptor, Off Road Material Hauler Future Increase(s): Add $1.60/hr on 5/30/2016.	33.02	19.15	52.17
205	Pavement Marking Vehicle	20.00	18.19	38.19
207	Truck Mechanic	20.00	18.19	38.19

LABORERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
301	General Laborer	29.01	17.39	46.40
302	Asbestos Abatement Worker	19.00	0.00	19.00
303	Landscaper	14.00	11.63	25.63
310	Gas or Utility Pipeline Laborer (Other Than Sewer and Water)	20.83	18.39	39.22
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	18.53	0.00	18.53
314	Railroad Track Laborer	17.00	5.43	22.43
315	Final Construction Clean-Up Worker	29.01	17.39	46.40

HEAVY EQUIPMENT OPERATORS
SITE PREPARATION, UTILITY OR LANDSCAPING WORK ONLY

CODE	Fringe Benefits Must Be Paid On All Hours Worked 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). Future Increase(s): Add $1.60/hr on 5/30/2016.	35.52	19.15	54.67
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). Future Increase(s): Add $1.60/hr on 5/30/2016.	35.52	19.15	54.67
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. Future Increase(s): Add $1.60/hr on 5/30/2016.	35.22	19.15	54.37
504	Work Performed on the Great Lakes Including Diver; Wet Tender or Hydraulic Dredge Engineer.	41.65	21.71	63.36
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. Future Increase(s): Add $1.25/hr on 1/1/2017. Premium Increase(s): Add $.50/hr for Friction Crane, Lattice Boom or Crane Certification (CCO).	44.05	23.24	67.29

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Future Increase(s): Add $1.25/hr on 1/1/2017.	39.20	23.09	62.29
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.	36.72	21.15	57.87

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

CODE	Fringe Benefits Must Be Paid On All Hours Worked 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. Premium Increase(s): 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.	41.66	20.65	62.31
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). Premium Increase(s): Crane Operators with CCO certification add $.50/hr.	41.16	20.65	61.81
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). Premium Increase(s): Crane Operators with CCO certification add $.50/hr.	40.66	20.65	61.31

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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).	39.97	20.65	60.62
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; 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.	38.09	20.65	58.74
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; Robotic Tool Carrier (With or Without Attachments); Rock, Stone Breaker; Skid Steer Loader (With or Without Attachments); Vibratory Hammer or Extractor, Power Pack.	32.94	20.65	53.59
514	Gas or Utility Pipeline, Except Sewer & Water (Primary Equipment). Future Increase(s): Add $1/hr on 5/30/2016.	37.04	22.44	59.48
515	Gas or Utility Pipeline, Except Sewer & Water (Secondary Equipment).	34.76	20.30	55.06
516	Fiber Optic Cable Equipment	21.00	0.00	21.00

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

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	35.89	18.77	54.66
105	Carpenter	34.13	20.61	54.74
107	Cement Finisher Future Increase(s): Add $1.75 on 6/1/16. Premium Increase(s): 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.	31.44	22.39	53.83
109	Electrician Future Increase(s): Add $1.60 on 6/1/16; Add $1.70 on 6/1/17 Premium Increase(s): 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.	35.13	23.19	58.32
111	Fence Erector	24.73	19.69	44.42
116	Ironworker	32.50	20.58	53.08
118	Line Constructor (Electrical)	40.81	18.06	58.87
125	Pavement Marking Operator	30.00	19.61	49.61
126	Piledriver	30.11	26.51	56.62
130	Plumber Future Increase(s): Add $1.50 on 6/1/16	39.95	19.45	59.40
135	Steamfitter	41.01	21.54	62.55
137	Teledata Technician or Installer	25.63	17.25	42.88
143	Tuckpointer, Caulker or Cleaner	34.28	18.60	52.88
144	Underwater Diver (Except on Great Lakes)	31.00	20.43	51.43
146	Well Driller or Pump Installer Future Increase(s): Add $1/hr on 6/1/2016; Add $1/hr on 6/1/2017.	25.32	16.40	41.72

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
150	Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	36.73	15.92	52.65
151	Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	32.65	14.96	47.61
152	Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	28.57	13.71	42.28
153	Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	26.53	13.55	40.08
154	Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	22.45	11.84	34.29

TRUCK DRIVERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
201	Single Axle or Two Axle	19.00	0.00	19.00
203	Three or More Axle	19.00	0.00	19.00
204	Articulated, Euclid, Dumptor, Off Road Material Hauler	33.69	19.78	53.47
205	Pavement Marking Vehicle	19.00	0.00	19.00
207	Truck Mechanic	19.00	0.00	19.00

LABORERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
301	General Laborer Future Increase(s): Add $1.25/hr eff. 06/06/2016 Premium Increase(s): Add $2.29 for bottomman; Add $2.15 for concrete manhole builder, bracer, jointman, or pipelayer; Add $5.44 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.	29.73	18.32	48.05
303	Landscaper	41.00	0.00	41.00
304	Flagperson or Traffic Control Person	19.31	15.21	34.52
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	18.53	0.00	18.53
314	Railroad Track Laborer	17.00	5.43	22.43

HEAVY EQUIPMENT OPERATORS
SEWER, WATER OR TUNNEL WORK

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Premium Increase(s): Add $.25/hr for operating tower crane.	38.09	20.80	58.89
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). Premium Increase(s): Add $.25/hr for operating tower crane.	37.31	20.80	58.11
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). Premium Increase(s): Add $.25/hr for operating tower crane.	36.36	20.80	57.16

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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.	33.69	21.75	55.44
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. Premium Increase(s): Add $.25/hr for operating tower crane.	33.91	20.80	54.71
526	Boiler (Temporary Heat); Forklift; Greaser; Oiler.	31.89	20.15	52.04
527	Work Performed on the Great Lakes Including Diver; Wet Tender or Hydraulic Dredge Engineer.	41.65	21.71	63.36
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.	41.65	21.71	63.36
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.	36.72	21.15	57.87
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.	36.72	21.15	57.87

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

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	31.55	18.52	50.07
105	Carpenter	34.13	20.71	54.84
107	Cement Finisher Future Increase(s): Add $1.75 on 6/1/16. Premium Increase(s): 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.	33.95	19.88	53.83
109	Electrician Future Increase(s): Add $1.60 on 6/1/16; Add $1.70 on 6/1/17 Premium Increase(s): 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.	35.13	23.19	58.32
111	Fence Erector	35.62	0.00	35.62
116	Ironworker	30.77	23.72	54.49
118	Line Constructor (Electrical)	40.81	18.06	58.87
124	Painter	29.87	18.79	48.66
125	Pavement Marking Operator	30.27	19.83	50.10
126	Piledriver	30.11	21.09	51.20
133	Roofer or Waterproofer	30.40	2.23	32.63
137	Teledata Technician or Installer	25.63	17.25	42.88
143	Tuckpointer, Caulker or Cleaner	34.28	18.60	52.88
144	Underwater Diver (Except on Great Lakes)	36.74	16.00	52.74
150	Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	36.73	15.92	52.65
151	Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	32.65	15.67	48.32

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
152	Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	28.57	13.71	42.28
153	Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	26.53	13.09	39.62
154	Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	22.45	11.84	34.29

TRUCK DRIVERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
201	Single Axle or Two Axle	36.72	21.15	57.87
203	Three or More Axle Premium Increase(s): 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.	25.78	18.96	44.74
204	Articulated, Euclid, Dumptor, Off Road Material Hauler Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	30.82	21.85	52.67
205	Pavement Marking Vehicle	23.82	17.72	41.54
206	Shadow or Pilot Vehicle	25.28	18.31	43.59
207	Truck Mechanic	25.28	18.31	43.59

LABORERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
301	General Laborer Future Increase(s): Add $1.00/hr eff. 06/01/2016; Add $1.00/hr eff. 06/01/2017 Premium Increase(s): 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).	27.51	20.63	48.14
302	Asbestos Abatement Worker	19.00	0.00	19.00
303	Landscaper Future Increase(s): Add $1.00/hr eff. 06/01/2016; Add $1.00/hr eff. 06/01/2017 Premium Increase(s): 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).	27.51	20.63	48.14
304	Flagperson or Traffic Control Person	23.55	20.03	43.58
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	18.53	0.00	18.53
314	Railroad Track Laborer	17.00	5.43	22.43

HEAVY EQUIPMENT OPERATORS
AIRPORT PAVEMENT OR STATE HIGHWAY CONSTRUCTION

Fringe Benefits Must Be Paid On All Hours Worked

CODE	TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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). Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	38.27	21.85	60.12
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	37.77	21.85	59.62

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	37.27	21.85	59.12

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	37.01	21.85	58.86
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx..	36.72	21.85	58.57
536	Fiber Optic Cable Equipment.	21.00	0.00	21.00
537	Work Performed on the Great Lakes Including Diver; Wet Tender or Hydraulic Dredge Engineer.	41.65	21.71	63.36
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.	41.65	21.71	63.36

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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.	36.72	21.15	57.87
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.	36.72	21.15	57.87

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

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
103	Bricklayer, Blocklayer or Stonemason	35.89	18.77	54.66
105	Carpenter Future Increase(s): Add $1.42/hr on 6/1/2016. Premium Increase(s): 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.	33.02	17.12	50.14
107	Cement Finisher	34.95	19.38	54.33
109	Electrician Future Increase(s): Add $1.60 on 6/1/16; Add $1.70 on 6/1/17 Premium Increase(s): 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.	35.13	23.19	58.32
111	Fence Erector	24.73	19.69	44.42
116	Ironworker	30.77	23.72	54.49
118	Line Constructor (Electrical)	40.81	18.06	58.87
124	Painter	29.62	20.74	50.36
125	Pavement Marking Operator	30.00	19.61	49.61
126	Piledriver Future Increase(s): Add $1.44/hr on 6/1/2016. Premium Increase(s): 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.	33.56	17.12	50.68
133	Roofer or Waterproofer	29.65	18.61	48.26
137	Teledata Technician or Installer	25.63	17.25	42.88
143	Tuckpointer, Caulker or Cleaner	34.28	18.60	52.88
144	Underwater Diver (Except on Great Lakes)	36.74	16.00	52.74
150	Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	36.73	15.92	52.65

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
151	Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	32.65	14.96	47.61
152	Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	28.57	13.71	42.28
153	Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	26.53	13.55	40.08
154	Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	22.45	11.84	34.29

TRUCK DRIVERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
201	Single Axle or Two Axle	19.00	0.00	19.00
203	Three or More Axle	19.00	0.00	19.00
204	Articulated, Euclid, Dumptor, Off Road Material Hauler Future Increase(s): Add $1.60/hr on 6/3/2016.	34.69	20.38	55.07
205	Pavement Marking Vehicle	19.00	0.00	19.00
206	Shadow or Pilot Vehicle	19.00	0.00	19.00
207	Truck Mechanic	19.00	0.00	19.00

LABORERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
301	General Laborer	29.01	17.39	46.40
303	Landscaper Future Increase(s): Add $1.00/hr eff. 06/01/2016; Add $1.00/hr eff. 06/01/2017 Premium Increase(s): 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).	27.51	20.63	48.14
304	Flagperson or Traffic Control Person	19.31	15.21	34.52
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	18.53	0.00	18.53

314	Railroad Track Laborer	17.00	5.43	22.43

HEAVY EQUIPMENT OPERATORS
CONCRETE PAVEMENT OR BRIDGE WORK

CODE	Fringe Benefits Must Be Paid On All Hours Worked 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. Future Increase(s): Add $1.60/hr on 6/3/2016. Premium Increase(s): Add $.50/hr for >200 Ton; Add $1/hr at 300 Ton; Add $1.50/hr at 400 Ton; Add $2/hr at 500 Ton & Over.	37.67	20.38	58.05
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	37.77	21.85	59.62

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	37.27	21.85	59.12
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	37.27	21.85	59.12

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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.	31.62	19.78	51.40
546	Fiber Optic Cable Equipment.	21.00	0.00	21.00
547	Work Performed on the Great Lakes Including Diver; Wet Tender or Hydraulic Dredge Engineer.	41.65	21.71	63.36
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. Future Increase(s): Add $1.25/hr on 1/1/2017. Premium Increase(s): Add $.50/hr for Friction Crane, Lattice Boom or Crane Certification (CCO).	44.05	23.24	67.29
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.	36.72	21.15	57.87
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.	36.72	21.15	57.87

HEAVY EQUIPMENT OPERATORS
ASPHALT PAVEMENT OR OTHER WORK

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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.	36.67	19.78	56.45

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017. Premium Increase(s): 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 $1.50/hr night work premium. See DOT'S website for details about the applicability of this night work premium at: http://wisconsindot.gov/Pages/doing-bus/civil-rights/labornwage/prevailing-wage-compliance.aspx.	37.77	21.85	59.62
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017.	36.72	21.50	58.22

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Future Increase(s): Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017.	36.72	21.50	58.22
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. Future Increase(s): Add $1.60/hr on 6/3/2016.	32.62	20.38	53.00
556	Fiber Optic Cable Equipment.	21.00	0.00	21.00

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	34.13	20.79	54.92
102	Boilermaker	30.21	21.97	52.18
103	Bricklayer, Blocklayer or Stonemason	30.00	2.54	32.54
104	Cabinet Installer	20.00	0.46	20.46
105	Carpenter	32.80	0.00	32.80
106	Carpet Layer or Soft Floor Coverer	24.04	4.89	28.93
107	Cement Finisher	25.00	12.00	37.00
108	Drywall Taper or Finisher	20.00	0.00	20.00
109	Electrician	27.00	6.24	33.24
110	Elevator Constructor	43.84	27.09	70.93
111	Fence Erector	17.00	0.17	17.17
112	Fire Sprinkler Fitter	39.66	21.11	60.77
113	Glazier	38.27	14.42	52.69
114	Heat or Frost Insulator	17.00	0.00	17.00
115	Insulator (Batt or Blown)	17.12	6.68	23.80
116	Ironworker	24.30	14.25	38.55
117	Lather	32.80	0.00	32.80
119	Marble Finisher	25.72	18.54	44.26
120	Marble Mason	30.00	2.54	32.54
121	Metal Building Erector	13.60	6.57	20.17
123	Overhead Door Installer	26.00	5.11	31.11
124	Painter	28.84	7.83	36.67
125	Pavement Marking Operator	30.00	19.61	49.61

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
129	Plasterer	22.00	0.00	22.00
130	Plumber	38.37	5.96	44.33
132	Refrigeration Mechanic	28.50	2.56	31.06
133	Roofer or Waterproofer Future Increase(s): Add $1.25/hr eff. 06/01/2016	30.45	18.60	49.05
134	Sheet Metal Worker	26.13	17.37	43.50
135	Steamfitter	15.00	2.04	17.04
137	Teledata Technician or Installer	22.50	12.74	35.24
138	Temperature Control Installer	21.42	7.84	29.26
139	Terrazzo Finisher	25.72	18.54	44.26
140	Terrazzo Mechanic	31.55	18.26	49.81
141	Tile Finisher	30.00	0.00	30.00
142	Tile Setter	31.00	0.00	31.00
143	Tuckpointer, Caulker or Cleaner	25.00	2.99	27.99
146	Well Driller or Pump Installer	29.00	0.00	29.00
147	Siding Installer	17.00	0.65	17.65

TRUCK DRIVERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
201	Single Axle or Two Axle	20.00	0.42	20.42
203	Three or More Axle	18.75	2.00	20.75
205	Pavement Marking Vehicle	18.75	2.00	20.75
207	Truck Mechanic	18.75	2.00	20.75

LABORERS

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
301	General Laborer	20.00	8.29	28.29
302	Asbestos Abatement Worker	18.00	5.52	23.52

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
303	Landscaper	22.61	0.00	22.61
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	18.53	0.00	18.53
315	Final Construction Clean-Up Worker	15.00	0.00	15.00

HEAVY EQUIPMENT OPERATORS
RESIDENTIAL OR AGRICULTURAL CONSTRUCTION

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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.	25.00	9.78	34.78
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. Future Increase(s): Add $1.60/hr on 5/30/2016.	34.17	19.15	53.32

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

Department of Workforce Development
Equal Rights Division
P.O. Box 8928
Madison, WI 53708-8928
Telephone: (608) 266-6860
Fax: (608) 267-4592
TTY: (608) 264-8752

STATE OF WISCONSIN
DWD
Department of Workforce Development

Scott Walker, Governor
Reginald J. Newson, Secretary

The documents following the Prevailing Wage Rate Determination consist of twenty pages (including this one) of various forms/documents that will be used throughout the completion of the project. This prevailing wage rate determination and its underlying legal requirements outlined in the attached documents apply for the life of this project even though work on the project continues into 2017 or beyond. The chart below lists the form number, form/document name, the party who uses the document, and the document's number of pages. If you have any questions regarding these forms please call the Prevailing Wage Office at (608)266-6861.

ERD Form Number	Form Name	Party Who Uses the Form	Pages
	July 2015 description of recent changes to Wisconsin's prevailing wage laws resulting from enactment of the 2015-17 State Budget Bill.		1
	Prevailing Wage - Public Entity Project Owners	Explanation of project owner responsibilities	2
16056	Post the White Sheet	Contracting agency	1
10908	Consolidated List of Debarred Contractors	Any party contracting someone to complete work on a prevailing wage project	4
	Prevailing Wage – Contractors	Explanation of contractor responsibilities	2
7777	Disclosure of Ownership	Contractors that meet the criteria set out in (3)(A)&(B) of the form	1
5724	Prime Contractor Affidavit of Compliance	Prime contractor files with contracting agency upon completion of the work before receiving final payment	2
10584	Agent or Subcontractor Affidavit of Compliance	Subcontractors file with their awarding contractor upon completion of their work on the project before receiving final payment	2
10880	Request to Employ Subjourneyperson	Contractors wishing to employ a subjourneyperson(s)	1
	Additional General Prevailing Wage Law Information	General information for public entity or any other interested party	3

12/22/2015

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STATE OF WISCONSIN
DWD
Department of Workforce Development

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Reginald J. Newson, Secretary

THE 2015-17 BUDGET BILL MADE SIGNIFICANT CHANGES TO WISCONSIN'S PREVAILING WAGE LAWS. HOWEVER, THOSE CHANGES DO NOT GO INTO EFFECT UNTIL JANUARY 1, 2017.

During calendar year 2016, DWD will continue to enforce prevailing wage laws for local governmental unit and state agency public works projects under current prevailing wage laws.

2015 Wisconsin Act 55 (the budget bill) repealed the state prevailing wage law for **local governmental units** such as villages, towns, cities, school districts, or sewerage districts effective January 1, 2017. However, if a local governmental unit:

- issues a Request for Bids before January 1, 2017, for a project of public works that is subject to bidding or,
- enters into a contract before January 1, 2017, for a project of public works that is not subject to bidding,

then those public works projects are subject to the current prevailing wage law (§66.0903, Wis. Stats.) through the life of the project. Projects of public works with prevailing wage project determinations issued prior to 2017 continue to be subject to the current prevailing wage law through the life of the project even though the project may have work going on in 2017 or subsequent years.

Contractors working on local governmental unit projects with prevailing wage rate determinations must continue to pay employees the appropriate prevailing wage and maintain required prevailing wage payroll records. For instance, if a contractor is working in 2018 on a public works project with a project determination issued prior to 2017, then the contractor is required to comply with the "old" prevailing wage rate law (§66.0903, Wis. Stats.). After January 1, 2017, DWD will continue to enforce prevailing wage requirements for projects with DWD prevailing wage determinations issued under the "old" prevailing wage laws (§§ 66.0903 & 103.49, Wis. Stats.).

For new public works projects starting on January 1, 2017, state prevailing wage law will only apply to **state agency** and **state highway** projects. Prevailing wage rates applicable to state agencies will be those issued by the U.S. Department of Labor under the Davis-Bacon Act, 40 U.S.C. 3142. The Wisconsin Department of Administration will enforce the new state agency prevailing wage law (§16.856, Wis. Stats.) and the Wisconsin Department of Transportation will continue to enforce prevailing wage on state highway projects (under a law renumbered as §84.062, Wis. Stats.).

(Updated-122215)

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STATE OF WISCONSIN
DWD
Department of Workforce Development

Scott Walker, Governor
Reginald J. Newson, Secretary

PREVAILING WAGE – Public Entity Project Owners

Any public works project that has a total estimated project cost that equals or exceeds single-trade or multiple-trade project thresholds requires a prevailing wage rate determination issued by the Department of Workforce Development (DWD). Public works include erecting, constructing, remodeling, repairing, demolishing, alterations, painting and decorating projects for a local governmental unit or state agency. State law excludes minor service or maintenance work, warranty work, or work under a supply-and-installation contract. There is a statutory definition for most of these exclusions. The prevailing wage law that applies to local governmental units is §66.0903, Wis. Stats. The prevailing wage law that applies to state agencies is §103.49, Wis. Stats. The applicable administrative rules for all public entities are DWD 290 and DWD 294, Wis. Adm. Code.

Thresholds

A "single-trade project of public works" means a project in which a single trade accounts for 85% or more of the total labor cost of the project. The single trade threshold is $48,000.

A "multiple-trade project of public works" means a project in which no single trade accounts for 85% or more of the total labor cost of the project.

(a) The multiple-trade threshold is $100,000, unless a municipality falls under the description in (b).

(b) The multiple-trade threshold of $234,000 applies to public works projects erected, constructed, repaired, remodeled, or demolished by a private contractor for •a city or village with a population less than 2500 or •a town.

A local governmental unit or state agency that has a public works project that equals or exceeds the prevailing wage thresholds must do all of the following:

- Request a prevailing wage rate determination for the project from DWD at least 30 days before soliciting bids or negotiating contracts. An Application for Prevailing Wage Rate Determination is available on the DWD website: http://dwd.wisconsin.gov/er/prevailing_wage_rate/default.htm
  To avoid waiting for a project determination use the on-line application system that permits the user to generate a determination immediately and save all documents in PDF form to the user's computer. Use this project determination on line application at the following address:

http://dwd.wisconson.gov/er/prevailing_wage_rate/pw_online_determinations.htm

- Tell potential contractors the project is subject to state prevailing wage law when soliciting bids.

- Include the prevailing wage rate determination in the construction contract, or if there is no written contract, provide a copy of the project determination to each prime contractor.

- Award contracts to contractors who do *not* appear on the "Consolidated List of Debarred Contractors."

- Notify contractors that they are required to have a written substance abuse testing program in place that fulfills the requirements of §103.503, Wis. Stats., before commencing work on the prevailing wage project.

- Post the prevailing wage rate determination on the project site. (This document is often referred to as "the white sheet.")

- Notify project contractors that if DWD finds that a contractor violated the prevailing wage law, DWD will assess liquidated damages of 100% of the wages owed to employees.

- Obtain an Affidavit of Compliance from each prime contractor before making final payment for the project.

If the total estimated cost of the project exceeds the prevailing wage thresholds, a local governmental unit or state agency also must obtain a prevailing wage rate determination under the following circumstances:

- when a completed facility is leased, purchased, lease-purchased or otherwise acquired by or dedicated to a public entity in lieu of the public entity contracting for the project,

- when one public entity does work for another public entity,

- when a *private* entity will construct a road, street, bridge, sanitary sewer or water main project and dedicate it to a local governmental unit or the state for its ownership or maintenance (except for some residential subdivisions).

For more information, visit the prevailing wage website: http://dwd.wisconsin.gov/er/prevailing_wage_rate/default.htm. For further assistance, call the Equal Rights Division at 608-266-6861 and ask for prevailing wage.

State of Wisconsin
Department of Workforce Development
Equal Rights Division
Labor Standards Bureau

POST THE WHITE SHEET

As the public entity receiving this prevailing wage rate determination, YOU ARE REQUIRED by law to post the prevailing wage rate determination (i.e., white sheet) in at least one conspicuous and easily accessible place on the project site that is available to all construction workers. The white sheet must remain posted from the onset of the project until all construction labor on the project has been completed.
[*See,* Wis. Admin. Code §DWD 290.12(1)]

Posting the white sheet inside the general contractor's trailer does not meet this requirement. That placement is not available/accessible to all workers and is not a location over which you have control.

If you have questions about posting, please call (608)266-6861 and ask for prevailing wage intake.

Consolidated List of Debarred Contractors
Prepared and Issued By
State of Wisconsin - Department of Workforce Development

January 1, 2016

This list has been prepared in accordance with the provisions of §§66.0903(12) and 103.49(7), Wis. Stats., and Chapter DWD 294 of the Wisconsin Administrative Code. All contractors on this list were found to have committed a "debarable offense" related to certain labor standard provisions determined or established for a state or local public works project. No state agency, local governmental unit or owner or developer may knowingly solicit bids from, negotiate with or award any contracts to or approve or allow any subcontracts with a debarred contractor, including all divisions, affiliates or other organizational elements of such contractor that are engaged in construction business activities, until the debarment is terminated. The name of each debarred contractor must remain on this list for a period of three (3) years from the termination date indicated below. The contractor is, however, only "debarred" from the "effective date" through the "termination date" indicated for that contractor. Questions regarding this list should be addressed to Jim Chiolino, Equal Rights Division, P. O. Box 8928, Madison, WI 53708 or call (608) 266-3345. Deaf, hearing or speech-impaired callers may contact the department by calling its TDD number (608) 264-8752.

Name of Contractor	Address	Effective Date	Termination Date	Cause Code	Date of Violation(s)	Limitations/ Deviations
A-1 Duran Roofing & Insulation Services, Inc.	3700 N Fratney St Milwaukee, WI 53212 or 8095 NW 64th St Miami, FL 33166	11/1/14	10/31/17	1, 2 and 4	2011-2012	None
Abel, Mike	*See,* Abel Electric, Inc					
Abel Electric, Inc	3385 Belmar Rd Green Bay, WI 54313	9/1/12	8/31/15	1	2011	None
Alpha Electric, LLC	350 Business Park Dr Sun Prairie, WI 53590	8/1/15	7/31/18	4	2014	None
Arnie Christiansen Mason Contractors, LLC	2304 65th Dr Franksville, WI 53126	9/1/14	8/31/16	1, 2 and 4	2011	None
Atkins, Scott	*See,* Freedom Insulation, Inc					
Boecker, Roger	*See,* R-Way Pumping, Inc					
Brechtl, Mark G	*See,* Ecodec, Inc					
Cargill Heating and Air Conditioning Company, Inc	3049 Edgewater La La Crosse, WI 54603	3/1/14	2/28/17	1 and 2	2011	None

Name of Contractor	Address	Effective Date	Termination Date	Cause Code	Date of Violation(s)	Limitations/ Deviations
Castlerock Commercial Construction, Inc	PO Box 11699 Milwaukee, WI 53211-0699	2/1/12	1/31/15	1, 2 and 4	2009 & 2010	None
Christiansen, Andy	*See,* Arnie Christiansen Mason Contractors, LLC					
Christiansen, Arnold	*See,* Arnie Christiansen Mason Contractors, LLC					
Darnick, Gregory L	*See,* Darnick Trucking, LLC					
Darnick Trucking, LLC	W914 County Rd V Berlin, WI 54923	11/1/14	10/31/15	1, 2 and 4	2012 & 2013	None
Dem/Ex Group, Inc	805 S Adams St Manito, IL 61546	12/1/11	11/30/14	1 and 2	2010	None
Duran, Bernardo	*See,* A-1 Duran Roofing & Insulation Services and RRS2 Inc					
Ecodec, Inc	5106 Wintergreen Dr Madison, WI 53704	10/1/14	9/30/17	1	2011 & 2012	None
Fisher, Ed &/or Fisher, Rhonda	*See,* Dem/Ex Group, Inc					
Freedom Insulation, Inc	117925 219th Ave Chippewa Falls, WI 54729	9/1/11	8/31/14	1	2008-2010	None
Froode, Kathleen M	*See,* Masonry Specialists II, LLC					
Galstad, Michael E (aka Michael Earl Galstad)	*See,* Cargill Heating and Air Conditioning Company, Inc					
Gjolaj, Ded	*See,* Horizon Bros Painting Corp					

Name of Contractor	Address	Effective Date	Termination Date	Cause Code	Date of Violation(s)	Limitations/ Deviations
Grade A Construction, Inc	157 Enterprise Rd Delafield, WI 53018	1/1/16	12/31/19	1, 2 and 4	2014	None
Horizon Bros Painting Corp	1053 Kendra La Howell, MI 48843	10/1/14	9/30/16	4	2012	None
JT Roofing, Inc	350 Tower Dr Saukville, WI 53080	6/1/12	5/31/15	1, 2 and 4	2007 & 2008	None
Jinkins, Richard	*See,* Castlerock Commercial Construction, Inc					
John's Concrete	*See,* Wagner Companies, Inc, dba John's Concrete					
Kott, Joseph J	*See,* Alpha Electric, LLC					
Masonry Specialists II, LLC	5109 Briarwood Ct Racine, WI 53402	8/1/15	7/31/18	4	2014	None
Mid-W Enterprises, Inc	1730 22nd Avenue Kenosha, WI 53140	6/1/15	5/31/17	1, 2 and 4	2013	None
Midwest Construction Co, Inc	*See,* Mid-W Enterprises, Inc					
Oden, Cassie	*See,* A-1 Duran Roofing & Insulation Services and RRS2 Inc					
Ofstie, Darin	*See,* Precision Excavating and Grading, LLC					
Peret, Robert	*See,* A-1 Duran Roofing & Insulation Services and RRS2 Inc					

Name of Contractor	Address	Effective Date	Termination Date	Cause Code	Date of Violation(s)	Limitations/ Deviations
Precision Excavating and Grading, LLC or Precision Excavating Enterprises, LLC	2104 Pierce Saint Croix Rd Baldwin, WI 54002	5/1/11	4/30/14	1, 2 and 4	2006-2008	None
R-Way Pumping, Inc	3023 Lake Maria Rd Freeport, MN 56331	3/1/12	2/28/15	1, 2 and 4	2008	None
RRS2 Inc.	133 N Jackson St, #427 Milwaukee, WI 53202 or 1313 N Franklin Pl, #805 Milwaukee, WI 53202	11/1/14	10/31/17	1, 2 and 4	2011-2012	None
Thull, Gerald T	*See,* JT Roofing, Inc					
Ventura, Robert	*See,* Mid-W Enterprises, Inc					
Wagner, Cory L	*See,* Wagner Companies, Inc					
Wagner Companies, Inc, dba John's Concrete	2063 Georgia Ave Racine, WI 53404	8/1/15	7/31/18	1	2013	None
Yaresh, Kathleen R	*See,* Grade A Construction, Inc					

Cause Code: 1 = Failure to Pay Straight Time 2 = Failure to Pay Overtime 3 = Kickback 4 = Payroll Records.

Department of Workforce Development
Equal Rights Division
P.O. Box 8928
Madison, WI 53708-8928
Telephone: (608) 266-6860
Fax: (608) 267-4592
TTY: (608) 264-8752

STATE OF WISCONSIN
DWD
Department of Workforce Development

Scott Walker, Governor
Reginald J. Newson, Secretary

PREVAILING WAGE – Contractors

Any public works project that has a total estimated project cost that equals or exceeds prevailing wage project thresholds requires a prevailing wage rate determination issued by the Department of Workforce Development (DWD). Public works include erecting, constructing, remodeling, repairing, demolishing, alterations, painting and decorating projects for a local governmental unit or state agency. State law excludes minor service or maintenance work, warranty work, or work under a supply-and-installation contract. There is a statutory definition for most of these exclusions. The prevailing wage laws that apply to local governmental units and their contractors are §§66.0903 and 103.503, Wis. Stats. The prevailing wage laws that apply to state agencies and their contractors are §§103.49 and 103.503, Wis. Stats. The applicable administrative rules for all prevailing wage projects are DWD 290 and DWD 294, Wis. Adm. Code. These laws include provisions that apply to all contractors and subcontractors working on prevailing wage projects.

Any contractor or subcontractor working on a local governmental unit or state agency's public works project that equals or exceeds current prevailing wage project thresholds must do all of the following:

- Receive and review the project's prevailing wage rate determination (i.e., white sheet).
- Tell subcontractors the project is subject to state prevailing wage law and include the prevailing wage rate determination in the construction contract, or if there is no written contract, provide a copy of the project determination to each subcontractor.
- Hire subcontractors who do *not* appear on the "Consolidated List of Debarred Contractors."
- Have a written substance abuse testing program in place that fulfills the requirements of §103.503, Wis. Stats., before commencing work on the project.

- Notify subcontractors that if DWD finds that a contractor or subcontractor violated the prevailing wage law, DWD will assess liquidated damages of 100% of the wages owed to employees.

- Apply to DWD for subjourney wage rates prior to employing these individuals on the project.

- Receive and retain a completed Affidavit of Compliance from each subcontractor brought on to the project before providing final payment to those subcontractors.

- Submit a completed Affidavit of Compliance to the contractor who brought the subcontractor on to the project before receiving final payment for the project.

- Maintain payroll records for 3 years that comply with §§66.0903(10)(a) or 103.49(5)(a), Stats. and DWD 274.06.

- Respond to requests from DWD or the project owner to provide payroll records and/or respond to prevailing wage complaints filed by employees or third parties.

For more information, visit the prevailing wage website: http://dwd.wisconsin.gov/er/prevailing_wage_rate/default.htm. For further assistance, call the Equal Rights Division at 608-266-6861 and ask for prevailing wage.

State of Wisconsin
Department of Workforce Development
Equal Rights Division

Disclosure of Ownership

The statutory authority for the use of this form is prescribed in Sections 66.0903(12)(d), 66.0904(10)(d) and 103.49(7)(d), Wisconsin Statutes.
The use of this form is mandatory. The penalty for failing to complete this form is prescribed in Section 103.005(12), Wisconsin Statutes.
Personal information you provide may be used for secondary purposes [Privacy Law, s. 15.04(1) (m), Wisconsin Statutes].

(1) On the date a contractor submits a bid to or completes negotiations with a state agency, local governmental unit, or developer, investor or owner on a project subject to Section 66.0903, 66.0904 or 103.49, Wisconsin Statutes, the contractor shall disclose to such state agency, local governmental unit, or developer, investor or owner, the name of any "other construction business," which the contractor, or a shareholder, officer or partner of the contractor, owns or has owned within the preceding three (3) years.

(2) The term "other construction business" means any business engaged in the erection, construction, remodeling, repairing, demolition, altering or painting and decorating of buildings, structures or facilities. It also means any business engaged in supplying mineral aggregate, or hauling excavated material or spoil as provided by Sections 66.0903(3), 66.0904(2), 103.49(2) and 103.50(2), Wisconsin Statutes.

(3) This form must ONLY be filed, with the state agency project owner, local governmental unit project owner, or developer, investor or owner of a publicly funded private construction project that will be awarding the contract, if **both (A) and (B) are met**.

(A) The contractor, or a shareholder, officer or partner of the contractor:
(1) Owns at least a 25% interest in the "other construction business," indicated below, on the date the contractor submits a bid or completes negotiations; or
(2) Has owned at least a 25% interest in the "other construction business" at any time within the preceding three (3) years.

(B) The Wisconsin Department of Workforce Development (DWD) has determined that the "other construction business" has failed to pay the prevailing wage rate or time and one-half the required hourly basic rate of pay, for hours worked in excess of the prevailing hours of labor, to any employee at any time within the preceding three (3) years.

Other Construction Business

Business Name			
Street Address or P O Box	City	State	Zip Code
Business Name			
Street Address or P O Box	City	State	Zip Code
Business Name			
Street Address or P O Box	City	State	Zip Code
Business Name			
Street Address or P O Box	City	State	Zip Code

I hereby state under penalty of perjury that the information, contained in this document, is true and accurate according to my knowledge and belief.

Print the Name of Authorized Officer			
Authorized Officer Signature	Date Signed		
Corporation, Partnership or Sole Proprietorship Name			
Street Address or P O Box	City	State	Zip Code

If you have any questions call (608) 266-6861

State of Wisconsin
Department of Workforce Development
Equal Rights Division

Prime Contractor Affidavit of Compliance With Prevailing Wage Rate Determination

Authorization for this form is provided under Sections 66.0903(9)(c), 66.0904(7)(c) and 103.49(4r)(c) Wisconsin Statutes.
The use of this form is mandatory. The penalty for failing to complete this form is prescribed in Section 103.005(12), Wisconsin Statutes.
Personal information you provide may be used for secondary purposes [Privacy Law, s. 15.04(1)(m), Wisconsin Statutes].

This form must **ONLY** be filed with the **Awarding Agency** indicated below.

State Of))SS County Of)	Project Name	
	DWD Determination Number	Project Number (if applicable)
	Date Determination Issued	Date of Contract
	Awarding Agency	
	Date Work Completed	

After being duly sworn, the person whose name and signature appears below hereby states under penalty of perjury that

- **I am** the duly authorized officer of the corporation, partnership, sole proprietorship or business indicated below and have recently completed all of the work required under the terms and conditions of a contract with the above-named awarding agency and make this affidavit in accordance with the requirements set forth in Section 66.0903(9)(c), 66.0904(7)(c) or 103.49(4r)(c), Wisconsin Statutes and Chapter DWD 290 of the Wisconsin Administrative Code in order to obtain FINAL PAYMENT from such awarding agency.
- **I have** fully complied with all the wage and hour requirements applicable to this project, including all of the requirements set forth in the prevailing wage rate determination indicated above which was issued for such project by the Department of Workforce Development on the date indicated above.
- **I have** received the required affidavit of compliance from each of my agents and subcontractors that performed work on this project and have listed each of their names and addresses on page 2 of this affidavit.
- **I have** full and accurate records that clearly indicate the name and trade or occupation of every worker(s) that I employed on this project, including an accurate record of the hours worked and actual wages paid to such worker(s).
- **I will** retain the records and affidavit(s) described above and make them available for inspection for a period of at least three (3) years from the completion date indicated above at the address indicated below and shall not remove such records or affidavit(s) without prior notification to the awarding agency indicated above.

Name of Corporation, Partnership, Sole Proprietorship, Business, State Agency or Local Governmental Unit				
Street Address	City	State	Zip Code	Telephone Number
Print Name of Authorized Officer			Date Signed	
Signature of Authorized Officer				

List of Agents and Subcontractors

Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number			Telephone Number		
Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number			Telephone Number		
Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number			Telephone Number		
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Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number			Telephone Number		
Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number			Telephone Number		
Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number			Telephone Number		

State of Wisconsin
Department of Workforce Development
Equal Rights Division

Agent or Subcontractor Affidavit of Compliance With Prevailing Wage Rate Determination

Authorization for this form is provided under Sections 66.0903(9)(b), 66.0904(7)(b) and 103.49(4r)(9b), Wisconsin Statutes. The use of this form is mandatory. The penalty for failing to complete this form is prescribed in Section 103.005(12), Wisconsin Statutes.
Personal information you provide may be used for secondary purposes [Privacy Law, Section 15.04(1)(m), Wisconsin Statutes].

This form must **ONLY** be filed with the **Awarding Contractor** indicated below.

State Of _____)	Project Name	
	DWD Determination Number	Project Number (if applicable)
)SS	Date Determination Issued	Date of Subcontract
County Of _____)	Awarding Contractor	
	Date Work Completed	

After being duly sworn, the person whose name and signature appears below hereby states under penalty of perjury that

- **I am** the duly authorized officer of the corporation, partnership, sole proprietorship or business indicated below. We have recently completed all of the work required under the terms and conditions of a subcontract with the above-named awarding contractor. We make this affidavit in accordance with the requirements set forth in Section 66.0903(9)(b), 66.0904(7)(b) or 103.49(4r)(b), Wisconsin Statutes and Chapter DWD 290 of the Wisconsin Administrative Code in order to obtain FINAL PAYMENT from such awarding contractor.
- **I have** fully complied with the entire wage and hour requirements applicable to this project, including all of the requirements set forth in the prevailing wage rate determination indicated above which was issued for such project by the Department of Workforce Development on the date indicated above.
- **I have** received the required affidavit of compliance from each of my agents and subcontractors that performed work on this project and have listed each of their names and addresses on page 2 of this affidavit.
- **I have** full and accurate records that clearly indicate the name and trade or occupation of every worker(s) that I employed on this project, including an accurate record of the hours worked and actual wages paid to such worker(s).
- **I will** retain the records and affidavit(s) described above and make them available for inspection for a period of at least three (3) years from the completion date indicated above at the address indicated below and shall not remove such records or affidavit(s) without prior notification to the awarding contractor.

Name of Corporation, Partnership, Sole Proprietorship, Business, State Agency or Local Governmental Unit				
Street Address or PO Box	City	State	Zip Code	Telephone Number ( )
Print Name of Authorized Officer			Date Signed	
Authorized Officer Signature				

List of Agents and Subcontractors

Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number ( )			Telephone Number ( )		
Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number ( )			Telephone Number ( )		
Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number ( )			Telephone Number ( )		
Name			Name		
Street Address			Street Address		
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Telephone Number ( )			Telephone Number ( )		
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Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number ( )			Telephone Number ( )		
Name			Name		
Street Address			Street Address		
City	State	Zip Code	City	State	Zip Code
Telephone Number ( )			Telephone Number ( )		

If you have any questions call (608) 266-6861

State of Wisconsin
Department of Workforce Development
Equal Rights Division
Labor Standards Bureau

Request to Employ Subjourneyperson

The use of this form is mandatory. The penalty for failing to complete this form is prescribed in Section 103.005(12), Wisconsin Statutes.
Personal information you provide may be used for secondary purposes (Privacy Law, s. 15.04(1)(m), Wisconsin Statutes].
The employer indicated below requests that the Department of Workforce Development (DWD) determine the prevailing wage rate(s) and related qualifications to enable such employer to use a subjourneyperson(s) on the following prevailing wage project, in accordance with the provisions of Section DWD 290.025, Wisconsin Administrative Code.

1. Name of Project Appearing on the Project Determination			
County	City, Village or Town		
DWD Project Determination Number	Project Number (if applicable)		
2. Job Classification(s) for which you request a subjourney rate (i.e., carpenter, electrician, plumber, etc.)			
a.	b.		
c.	d.		
3. Employer Name (Print)	Requester Name (Print)		
Address	City	State	Zip Code
Telephone Number ( )	Requester Title		
Email address (if you prefer to receive your response via email)	Fax Number (if you prefer to receive your response via fax) ( )		

READ CAREFULLY: I understand that this request is ONLY applicable to the project and job classification(s) listed above and that subjourney employees primarily work under the direction of and assist a skilled trade employee by frequently using the tools of a skilled trade and will NOT regularly perform the duties of a general laborer, heavy equipment operator or truck driver. If the subjourney employee regularly performs the work of a different trade or occupation, he/she will be compensated for such work at the applicable journeyperson prevailing wage rate. I agree to compensate subjourney employees in strict accordance with the directions received from the DWD.

Requester Signature	Date Signed

MAIL the completed request to:
EQUAL RIGHTS DIVISION, LABOR STANDARDS BUREAU
PO BOX 8928, MADISON WI 53708
OR
FAX the completed request to: (608) 267-4592 / **DO NOT e-mail your request.**
Call (608) 266-6861 for assistance in completing this form.

ERD-10880 (R. 6/2013)

ADDITIONAL GENERAL PREVAILING WAGE LAW INFORMATION

(This document updated July 2015)

NOTE: Recent prevailing wage law changes enacted by the 2015-17 Budget Bill (2015 Wisconsin Act 55) do not go into effect until calendar year 2017.

For prevailing wage laws and frequently asked questions, refer to the prevailing wage website at: http://dwd.wisconsin.gov/er/prevailing_wage_rate/default.htm

Topic	Who's affected?	Brief description of requirement under §66.0903 or §103.49
Non-applicability	All public entities	Prevailing wage rates do not apply to minor service or maintenance work, warranty work, or work under a supply and installation contract.
Non-applicability: Minor service or maintenance work	Local governmental units & Contractors	Minor service or maintenance work means a project of public works that is limited to • minor crack filling, chip or slurry sealing, or other minor pavement patching, not including overlays, that has a projected life span of no longer than 5 years or that is performed for a TOWN and is not funded under §86.31, regardless of projected life span; • the depositing of gravel on an existing gravel road applied solely to maintain the road; • road shoulder maintenance; • cleaning of drainage or sewer ditches or structures; or • any other limited, minor work on public facilities or equipment that is routinely performed to prevent breakdown or deterioration.
Non-applicability: Minor service or maintenance work	State agencies	Minor service or maintenance work means a project of public works that is limited to • minor crack filling, chip or slurry sealing, or other minor pavement patching, not including overlays, that has a projected life span of no longer than 5 years; • cleaning of drainage or sewer ditches or structures; or • any other limited, minor work on public facilities or equipment that is routinely performed to prevent breakdown or deterioration.
Non-applicability: Supply & installation contract	All public entities	Supply and installation contract means a contract under which the material is installed by means of simple fasteners or connectors such as screws or nuts and bolts and no other work is performed on the site of the project of public works, and the total labor cost to install the material does not exceed 20 percent of the total cost of the contract.
Non-applicability: Work which a contractor or individual donates to a public entity	All public entities	Prevailing wage laws §§66.0903 & 103.49, Stats., do not apply to work performed on a project of public works for which the local governmental unit or the state or the state agency contracting for the project is not required to compensate any contractor, subcontractor, contractor's or subcontractor's agent, or individual for performing the work.

Topic	Who's affected?	Brief description of requirement under §66.0903 or §103.49
Non-applicability: Residential	All public entities	A prevailing wage rate determination is not required for the erection, construction, repair, remodeling, or demolition of a residential property containing 2 dwelling units or less.
Non-applicability: Residential subdivision infrastructure	All public entities	A prevailing wage rate determination is not required for a road, street, bridge, sanitary sewer, or water main project that is a part of a development in which at least 90 percent of the lots contain or will contain 2 dwelling units or less, as determined by the local governmental unit at the time of approval of the development, and that, on completion, is acquired by, or dedicated to, a local governmental unit (including under §236.13(2), Stats.), or the state, for ownership or maintenance by the local governmental unit or the state.
Electronic certified payroll record	Contractors	The requirement that every contractor on a prevailing wage project submit to DWD monthly a certified record of employees who worked on the project and that DWD post these certified records on its Internet website was discontinued effective July 1, 2011. Contractors are still required to maintain payroll records and provide them upon request from DWD &/or the project owner.
Payroll record inspection request by any person	Contractors & Complainants	Any person may request DWD to inspect the payroll records of any contractor working on a prevailing wage project. On receipt of such a request, the contractor must submit to DWD a certified record of its payroll records, other than personally identifiable information relating to an employee of the contractor, for no longer than a 4-week period. DWD may request records from a contractor under this provision no more than once per calendar quarter for each project of public works on which the contractor is performing work. The department may not charge a requester a fee for obtaining that information. DWD must make these certified records available for public inspection.
Statewide uniformity	Local govern-mental units	A local governmental unit may not enact & administer a prevailing wage ordinance/provision for public works or publicly funded private construction projects. Any extant laws to that effect are void.
Substance Abuse Testing	Contractors & Workers	Before commencing work on a prevailing wage project, a contractor must have a written substance abuse testing program in place that complies with §103.503, Wis. Stats. No employee may use, possess, attempt to possess, distribute, deliver, or be under the influence of a drug or under the influence of alcohol while performing work on a prevailing wage project.

Topic	Who's affected	Brief description of requirement under §66.0903 or §103.49
Covered employees	Truck drivers & Other workers & Contractors	A laborer, worker, mechanic, or truck driver who is employed to process, manufacture, pick up, or deliver materials or products from a commercial establishment that has a fixed place of business from which the establishment supplies processed or manufactured materials or products or from a facility that is not dedicated exclusively, or nearly so, to a project of public works is NOT entitled to receive the prevailing wage rate UNLESS any of the following applies: 1) the laborer, worker, mechanic, or truck driver is employed to go to the source of mineral aggregate such as sand, gravel, or stone and deliver that mineral aggregate to the site of a project of public works by depositing the material directly in final place, from the transporting vehicle or through spreaders from the transporting vehicle. 2) the laborer, worker, mechanic, or truck driver is employed to go to the site of a project of public works, pick up excavated material or spoil from the site of the project, and transport that excavated material or spoil away from the site of the project.

NOTICE

ALL PREVAILING WAGE CONTRACTS AWARDED BY THE DEPARTMENT OF PUBLIC WORKS AFTER THE FIRST OF ANY CALENDAR YEAR ARE SUBJECT TO THE NEW PREVAILING WAGE SCHEDULE THAT GOES INTO EFFECT ON JANUARY 2ND. THE PREVAILING WAGE SCHEDULE INCLUDED IN BID PACKAGES ISSUED LATE IN THE PRECEDING YEAR MAY NOT BE TOTALLY ACCURATE FOR CONTRACTS OFFICIALLY AWARDED AFTER THE TURN OF THE YEAR. THE NEW PREVAILING WAGE WILL BE INCORPORATED INTO THE CONTRACT WHEN AWARDED.

BIDDERS ARE REQUIRED TO UTILIZE THE WISCONSIN DEPARTMENT OF WORKFORCE DEVELOPMENT'S "DICTIONARY OF OCCUPATIONAL CLASSIFICATIONS AND WORK DESCRIPTIONS" TO DETERMINE THE APPROPRIATE JOB CLASSIFICATIONS AND WAGE RATES FOR THEIR EMPLOYEES PRIOR TO BIDDING. THIS DOCUMENT CAN BE FOUND ON THEIR WEBSITE AT DWD.WISCONSIN.GOV; TYPE "DICTIONARY" IN THE SEARCH BOX.

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.

Title	Sheets Thru
TITLE SHEET	T001
ARCHITECTURAL	
PARTIAL BASEMENT FLOOR - DEMOLITION AND NEW WORK	A110
PARTIAL FIRST FLOOR DEMOLITION AND NEW WORK	A120
ROOF DEMOLITION AND NEW WORK	A130
HEATING, VENTILATING AND AIR CONDITIONING	
MECHANICAL SYMBOLS AND ABBREVIATIONS	M001
MECHANICAL BASEMENT DEMOLITION PLAN	MD101
MECHANICAL OVERALL IRST FLOOR DEMOLITION PLAN	MD102
MECHANICAL PARTIAL FIRST FLOOR DEMOLITION PLAN – AREA A	MD103
MECHANICAL PARTIAL FIRST FLOOR DEMOLITION PLAN – AREA B	MD104
MECHANICAL OVERALL ROOF DEMOLITION PLAN	MD105
MECHANICAL PARTIAL ROOF DEMOLITION PLAN – AREA A	MD106
MECHANICAL BASEMENT PLAN	M101
MECHANICAL OVERALL FIRST FLOOR PLAN	M102
MECHANICAL PARTIAL FIRST FLOOR PLAN – AREA A	M103
MECHANICAL PARTIAL FIRST FLOOR PLAN – AREA B	M104
MECHANICAL OVERALL ROOF PLAN	M105
MECHANICAL PARTIAL ROOF PLAN – AREA A	M106
MECHANICAL PARTIAL ROOF PLAN – AREA B	M107
MECHANICAL DETAILS	M501
MECHANICAL DETAILS	M502
MECHANICAL SCHEDULES	M601
ELECTRICAL	
ELECTRICAL SYMBOLS, ABBREVIATIONS AND GENERAL NOTES	E001
ELECTRICAL BASEMENT DEMOLITION PLAN	ED101
ELECTRICAL PARTIAL FIRST FLOOR DEMOLITION PLAN – AREA A	ED102
ELECTRICAL PARTIAL FIRST FLOOR DEMOLITION PLAN – AREA B	ED103
ELECTRICAL PARTIAL ROOF DEMOLITION PLAN – AREA A	ED104
ELECTRICAL PARTIAL ROOF DEMOLITION PLAN – AREA B	ED105

Title	Sheets Thru
ELECTRICAL BASEMENT PLAN	E101
ELECTRICAL PARTIAL FIRST FLOOR PLAN – AREA A	E102
ELECTRICAL PARTIAL FIRST FLOOR PLAN – AREA B	E103
ELECTRICAL PARTIAL ROOF PLAN – AREA A	E104
ELECTRICAL PARTIAL ROOF PLAN – AREA B	E105
MECHANICAL EQUIPMENT SCHEDULE	E501
ELECTRICAL PANEL SCHEDULES	E601
ELECTRICAL PANEL SCHEDULES	E602
ELECTRICAL PANEL SCHEDULES	E603
ONE-LINE DIAGRAM	E701

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. City of Milwaukee, Milwaukee Police Department, 7th District Police Station, RTUs Replacement.

1. **Base Bid:**

a) Provide two new rooftop AHUs and an energy recovery ventilator to replace two existing rooftop AHUs and an energy recovery ventilator. Provide new rooftop ductwork, and piping modifications as required by installation of new AHUs and energy recovery ventilator in different locations than the existing equipment.

b) Provide demolition of existing rooftop AHUs, energy recovery ventilator and an old multi-zone AHU in the basement. Demolish connected, ductwork and piping associated with this equipment.

c) Provide simple thermostat control of the new rooftop AHUs and interlock operation of the energy recovery ventilator with one of the new AHUs. AHUs and energy recover ventilator shall be connected and integrated into existing Trane BCU controller.

d) Provide test and balance of the new rooftop AHUs and an energy recovery ventilator (work by others under separate contract with the City).

2. **Alternate Bid No.1:**

VAV Retrofit

a) Provide new VAV boxes with electric reheat coils and electric heating coils in the existing supply air ductwork distribution system. Provide modifications to the existing ductwork to accommodate the installation of the new VAV boxes and heating coils.
b) Provide new transfer air ductwork and grilles. Provide new supply and return ductwork for rooms that are presently not conditioned.
c) Provide direct digital controls for the new VAV boxes and reheat coils and interface with the existing Trane Tracer system (BCU).

3. **Alternate No. 2:**

Replace Garage HV

a) Provide a new gas–fired heating and ventilating unit for the Garage to replace the existing heating and ventilating unit. Provide new ductwork, gas piping, power and controls associated with the new unit. New garage unit and associated gas detection and ventilation shall be connected and integrated into existing Trane BCU controller.
b) Provide demolition of the existing heating and ventilating unit.

4. **Alternate No. 3:**

   Replace PRV Fans

   a) Provide new roof-mounted exhaust fans for the Garage and the Restrooms including associated controls.

5. **Alternate No. 4:**

   Replace Controls Head End

   a) Replace existing Trane Tracer BCU with bridge, SE controller and Ethernet switch. All existing equipment on the BCU shall be migrated into the new SE controller and provided with new graphics interface at the Police Administration Building (4 PCs).

6. **Alternate No. 5:**

   Replace Duct Smoke Detectors

   a) Replace existing duct smoke detectors in exhaust duct from each holding cell with new ionization type duct smoke detectors. Include sampling tube, remote testing station and HVAC equipment shutdown interlock to new HVAC equipment (starter, VFD, etc.).

B. The City of Milwaukee Police Department (MPD) will occupy during entire period of construction to conduct normal operation. Cooperation with the City during project construction operation to minimize conflicts and facilitate City's normal operations. Contractor shall, at times, conduct operation to ensure least inconvenience to the City and other contractors.

C. The Contractor shall coordinate all work activities with the City, utilities, and all other work forces on each site.

D. It is understood that the submittal of a proposal shall include furnishing all labor, materials, equipment, and incidentals necessary for completion of the work required, including that which may not be directly shown on the drawings or in the specifications, but are necessary for proper operation and approval.

E. Examine Documents and Visit Site:

   1. Before submitting a bid proposal, bidders should carefully examine the drawings and specifications; visit the site of work; 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 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:

A. Testing and Balancing under a separate contract with the City.

B. All electrical work is to be performed by the City Electricians with the exception of HVAC Control wiring. Contractor shall supply loose to the City motor starters, disconnect switches and variable frequency drives as shown on drawings.

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.

C. Contractor must notify DPW, ISD - BRIDGES AND BUILDINGS Section 48 hours in advance before starting work.

D. Site work is not to proceed without authorization from the owner or its engineer/consultant or before a Pre-Construction Meeting.

E. Contractor shall schedule and execute construction activities in a manner which minimizes disruption of operations. As such, construction activities shall be carried out in a contiguous fashion.

F. All work shall be completed within the time period designated in the contract documents.

G. Contractor shall protect existing equipment, floors, and walls from all construction debris and damage

H. The contractor shall sign in and identify all personnel working at the site on a daily basis with the supervisor in charge at the site. All personnel leaving the site will sign out prior to departure.

I. Shut downs of any equipment and connections to any equipment must be arranged in advance with the Project Inspector from BRIDGES AND BUILDINGS. Power outages must be scheduled for Saturdays.

J. Dispose of all removed materials in legal manner.

K. Project Total working days do not include submittals and submittal approval, acquisition and preparation of materials, and work off-site..

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 Operations Manager of BRIDGES AND BUILDINGS SECTION. 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. BRIDGES AND BUILDINGS SECTION 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.

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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.

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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. Temporary hoists, Lifts
6. Temporary Ladders, Scaffolds
7. Electrical Power
8. Water
9. Toilet Facilities
10. Parking
11. Barricades and Signage
12. Construction Reference and Storage Area

2. BUILDING SECURITY:

A. General

1. The City Hall Complex is open to the public from 8:00 a.m. until 4:45 p.m., Monday through Friday excluding Holidays. It is essential that contractors and their City agents understand and abide by security policy. Any work performed at any time in the Mayor's Office, City Clerk, Treasurer, Budget, or City Attorney offices must be cleared in advance with representatives from those offices.

2. 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. Scope

At the beginning of any project, a copy of this policy and procedure statement will be added to specifications for bid consideration and shall be distributed at the pre-construction meeting. All City agents/officials responsible for engaging contractors, all contractors, and all sub-contractors shall be held responsible for following the procedures.

C. 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. The "minimum" background check requires 3 days for clearance. Staff with "minimum background check must be supervised by on site staff/contractor with **CJIS clearance**, (see following).

3. Contractor requiring access to the site, including any subcontractors, suppliers or

vendors will be required to assign at least one staff member responsible for monitoring construction access through the complex. This designated staff shall 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 5 (five) 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). Clearance process takes 4 (four) weeks after fingerprinting. If cleared back-ground check, this staff will be designated "Sponsor" and will be issued a **CJIS ID card**.

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. Staff given this clearance will only be allowed access to the building under the supervision of a "Sponsor".

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

6. **CJIS ID card** must be returned at the completion of the project.

7. **A penalty of $1,000** will be issued for each card not returned at the substantial completion of the project. The contractor is responsible for the return of these cards. The penalty will be deducted from the contract 30 days after notification.

D. City Agents

Any City agent who commissions outside contractors to work in any of the facilities managed by DPW-BRIDGES AND BUILDINGS shall provide a completed Contractor Authorization form to DPW-Facilities no less than twenty-four (24) hours in advance of the work.

1. The completed form will be provided to the Security Operations Manager and the City Hall Information Center. The inspector or city agent managing the project will provide this information in conjunction with the contractor. If the work is completed in outlying buildings the City agent shall be responsible for gaining and controlling access in that facility.
2. All access requirements must be included on the Contractor Authorization form. Critical information includes a list of keys and/or access cards required. In addition, access to more secure areas shall be explicitly requested. Secure areas may require additional scrutiny. Work in secure areas will not commence until all necessary approvals have been obtained. More secure areas may include private offices, inventory rooms, mechanical areas, data rooms, etc. In most cases keys or access cards required to do work in the outlying buildings will be the responsibility of the Maintenance Technician or Construction Inspector. Keys or access cards needed for work in the City Hall Complex will be checked out by the Information Center, once approved.

E. Contractors

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 determine by the contracting City agent/official.

1. All access should be arranged in advance through the City agent. Contractors shall enter

and exit only through those doors designated by City agents (ex: the Market Street entrance to City Hall, doors established by the person responsible for access at the outlying buildings). All other exterior doors are locked and alarmed and are not to be used as delivery points unless the City agent/officials has been provided 24 hour notification to provide additional security coverage at that point while the delivery is in progress.

2. All of the contractor's employees and all of the employees of any sub-contractor shall be clearly identifiable as a contractor via uniform or clearly visible company picture ID.

3. Contractors will sign in on pre-approved forms and also wear City issued identification badges (in the City Hall Complex).

4. Keys or access cards will be signed out as necessary with approval from the City agent/official. The contractor must leave their drivers license. All keys, cards, and badges must be returned at the end of each shift before the contractor's driver license will be returned. Failure to do so will result in a $50.00 penalty for each occurrence.

5. Contractors shall not ask custodians or mechanics to unlock doors. All access should be provided in advance through the City agent/official. In the rare case where access is not provided, the City Hall operator may be contacted to assist in providing access. The contractor shall cooperate with security personnel at all times. 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. Security will question a contractor who has an identification badge that indicates a work area other than the area he or she is in.

6. If the contractor requires use of the loading dock in Upper Parking, 24 hour advanced notice shall be given to the City agent/official to make arrangements to provide additional security coverage while the delivery is in progress. 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.

7. If after hours work is required in the outlying buildings, all subcontractors and trades will arrange appropriate security and lock-up procedures with the contractor, in advance and in writing to the satisfaction of the City agent. 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.

8. 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 they are working during construction to the satisfaction of DPW-BRIDGES AND BUILDINGS and the City agent (if different).

9. 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.

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

11. 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:

The owner will occupy the premises while work is in progress. Contractor is to coordinate his work as to not interfere with the owner's operation or compromise building security.

5. TEMPORARY HOISTS, LIFTS:

Contractors and subcontractors requiring hoists or lifts shall provide their own and remove upon completion of work.

6. TEMPORARY LADDERS, SCAFFOLDS:

A. Contractors and subcontractors requiring scaffolds, chutes, and ladders shall provide their own and remove them upon completion of work.

B. Each contractor shall furnish and maintain equipment such as fixed ladders, chutes, and the like as required for proper execution of their work.

7. ELECTRICAL POWER:

A. Contractor may use existing outlets for power. Contractor is to supply his own extension cords. All current used will be provided and paid by the City of Milwaukee.

B. OSHA regulations require that employers use either ground fault circuit interrupters or an assured equipment grounding conductor problem in addition to any other regulations for equipment grounding conductors.

8. 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.

9. TOILET FACILITIES:

Contractor may use existing toilet facilities in the building but will then be responsible to ensure that the facility is kept in a sanitary condition.

10. PARKING:

Contractor is responsible for parking of vehicles. No parking areas will be provided by the City.

11. BARRICADES AND SIGNAGE:

Contractor is to provide barricades and signage as required by OSHA and City/State Codes for their work.

12. CONSTRUCTION REFERENCE AND STORAGE AREA:

The contractor is to provide desks or other suitable surfaces for himself, his subcontractors, and the City Project Inspector for the purpose of viewing plans, project manuals, and other construction related documents. The contractor is also to provide filing cabinets or document boxes or other suitable containers for himself, his subcontractors, and the City Project Inspector for the purpose of storing plans, project manuals, shop drawings, and other construction related documents that he is required by this contract to keep on site.

SECTION 01505: CONSTRUCTION WASTE MANAGEMENT

PART 1 - 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:

1. Developing a Construction Waste Management Plan including waste management goals and provisions for waste reduction and recycling.
2. Implementing, monitoring and documenting the waste management plan.
3. Incorporating special programs.
4. 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

1. Section 01010 “Summary of Work”
2. Section 01300 “Submittal & Permits”
3. Section 001500 “Utilities, Facilities, and Security” for environmental-protection measures during construction.

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

1. 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.
2. 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. **The Plan, which should be entered into and generated by WasteCapTRACE, shall include the following:**

1. **A list of the waste materials expected to be generated from the Project debris.**
2. **A list of each material proposed to be salvaged, reused, recycled and discarded. Identify applicable markets for reuse and recycling. At a minimum, all materials required by state law to be recycled shall be recycled (e.g., cardboard, cans, bottles, office paper, fluorescent tubes, refrigerants, mercury, etc.) and scrap metal shall be recycled.**
3. **Separation and materials handling procedures: Description of how waste materials identified above will be separated, cleaned (if necessary) and protected from contamination.**
4. **Educational and Motivational Procedures: Meetings to be held and other proposed methods for educating construction personnel regarding waste reduction and recycling. Construction waste management requirements should be discussed at least monthly at project site meetings.**
5. **Waste Auditing Procedures: Methods of monitoring and enforcing the Plan.**
6. **Documentation Procedures: Methods of documenting materials leaving the Project site as waste, for the reuse or recycling to allow Summary of Waste Progress Reports to be submitted with Applications for Payment.**
7. **The Lead contractor shall distribute copies of the Construction Waste Management Plan to DPW's Project manager.**

C. 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.

1. Document on the Form acceptable to the Owner and Architect.
2. With each Application for Payment, submit updated documentation identifying solid waste disposal and diversion.
3. With each Application for Payment, submit manifests, weight tickets, receipts and invoices identifying the Project and construction waste material.

D. Record Submittals: Submit the following:

1. Summary of solid waste disposal and diversion. Submit on form acceptable to the Owner and Architect.
2. 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 **25%** 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. 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:
1. 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.
2. Cover materials with tarps and keep truckloads level so as to prevent spillage.
3. Arrange for collection by or delivery to the appropriate recycling or reuse facility.
4. 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:
1. Sorting recyclable materials at the Project site and transporting them to recycling markets directly from the Project site.
2. 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.

1.7 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. **This reporting shall take place using WasteCapTRACE, an**

online documentation system. There is a fee, to be included in the bid, of two cents per square foot of gross construction for use of WasteCapTrace. Failure to submit this information shall render the Application for Payment void, thereby delaying the Progress Payment.

G. The Summary of Waste shall contain the following information:

1. 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, weighing tickets, receipts and invoices.
2. 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 cost or savings of recycling. Include corresponding manifests, weight tickets, receipts and invoices.
3. **Final Payment: Prior to application for Final Payment, the Lead contractor shall submit a Final Summary of Waste: reuse and recycling results for all prime and subcontractors, including the quantity of each material recycled, reused, or salvaged, the receiving party and the applicable diversion rates. The final report will be generated by WasteCapTRACE based on information entered throughout the project by the Lead Contractor.**

H. 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.

1.8 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 BRIDGES AND BUILDINGS Section 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.

D. All solvents and cleaners used on this project must be rated as containing low or no volatile organic compounds (VOC's).

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.

D. All solvents and cleaners used on this project must be rated as containing low or no volatile organic compounds (VOC's).

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 contractor shall provide DPW BRIDGES AND BUILDINGS SECTION 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.

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 (and one electronic copy) to BRIDGES AND BUILDINGS SECTION.

E. Contractor shall provide qualified personnel onsite to provide a minimum of four (4) hours of training to Owner's representatives.

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 01820: TRAINING

1. SCOPE:

A. Index:

1. Scope
2. Training, Operations Instructions, and Maintenance Manuals

2. TRAINING, OPERATIONS INSTRUCTIONS, AND MAINTENANCE MANUALS:

A. This contractor shall, upon completion of the work, instruct City personnel in the operation, adjustment, and maintenance of the HVAC equipment, HVAC controls, fire protection, and life/safety (fire alarms) systems, and lighting controls (by City of Milwaukee).

1. Training for HVAC equipment.

2. Training for HVAC controls.

3. Training for fire protection and life/safety (fire alarms) systems.

4. Training for electrical lighting controls (by City of Milwaukee).

B. Training for HVAC Equipment:

Two levels of on–site training exist for the Downtown Complex Facilities Management staff. In addition to two levels of training, off-site training is appropriate for advanced subjects and particular employees. In total, there are three types of training. The number of training hours varies and is dependent on the scope of the project and complexity of the equipment.

1. On-Site Training:

a. Factory certified trainer to provide training for managers, engineers, mechanics, electricians, and technicians.

b. Service representative to provide operations and maintenance training.

2. Training Hours and Frequency (On-Site Training):

a. Level I:

To be provided upon the completion of the project. Training will be a 1 day minimum. Use of O & M manuals is required. Training is administered in a classroom and field setting (no more than 4 hours at a given session). Reference manufacturer's course offerings for details. This project will require a minimum of 8 hours of training. Level I training is administered to managers, engineers, mechanics, electricians, technicians, and others who interact with HVAC equipment and facilities maintenance.

b. Level II:

Two hour segments, 1 time per hear, 2nd shift only, 2 hours per year (depending in complexity) total. This training serves as both a review and a systems development preview.

C. Training for HVAC Controls:

Two levels of on-site training exist for the Downtown Complex Facilities Management staff. In addition to the two levels of training, off-site training is appropriate for advanced subjects and particular employees. In total, there are three types of training. The number of training hours varies and is dependent on the scope of the project and complexity of the equipment.

1. On-Site Training:

   a. Factory certified trainer to provide training for managers, engineers, mechanics, electricians, technicians, and support staff.

   b. Service representative to provide operations and maintenance training.

   c. Training for switchboard operators and facility supervisors.

2. Off-Site Training:

   a. Off-site training is reserved for complex applications where the factory has a technical training schedule specific to troubleshooting, systems diagnostics, maintenance, and operations. Typically, there will be beginning, intermediate, and advanced level courses offered by the manufacturer. **The course will be selected by the Operations and Maintenance Manager**.

3. Training Hours and Frequency (On-Site Training):

   a. Level I:

      To be provided upon the completion of the project. Training will be a 1 day minimum. Use of O & M manuals is required. Training is administered in a classroom setting (no more than 4 hours at a given session). Reference manufacturer's course offerings for details. This project will require a minimum of 8 hours of training. Level I training is administered to managers, engineers, mechanics, electricians, technicians, support staff, and others who interact with equipment, hardware, software, and facilities maintenance.

   b. Level II:

      Two hour segment, 1 time per year, 2nd shift, 2 hours per year total. This training serves as both a review and a systems development preview.

D. Training for Fire protection and Life/Safety (Fire Alarm) Systems:

Two levels of on-site training exist for the Downtown Complex Facilities Management staff. In addition to the two levels of training, off-site training is appropriate for advanced subjects and particular employees. In total, there are three types of training. The number of training hours varies and is dependent on the scope of the project and complexity of the equipment.

1. On-site Training:

a. Factory certified trainer to provide training for managers, engineers, mechanics, electricians, technicians, and support staff.

b. Service representative to provide operations and maintenance training.

c. Training for switchboard operators and facility supervisors.

2. Off-Site Training:

a. Off-site training is reserved for complex applications where the factory has a technical training schedule specific to troubleshooting systems diagnostics, maintenance, and operations. Typically, there will be beginning, intermediate, and advanced level courses offered by the manufacturer. **The Operations and Maintenance Manager will select classes**.

3. Training Hours and Frequency (On-Site Training):

a. Level I:

To be provided upon the completion of the project. Training will be a 2 day minimum. Use of O & M manuals is required. Training is administered in a classroom setting (no more than 4 hours at a given session). Reference manufacturer's course offerings for details. This project will require a minimum of 8 hours training. Level I training is administered to managers, engineers, mechanics, electricians, support staff, and others who interact with equipment, hardware, software, and facilities maintenance.

b. Level II:

Two hour segment 1 time per year, 2nd shift and 3rd shift, 2 hours per year total. This training serves as both a review and a systems development preview.

E. Training for Electrical Lighting Controls (City of Milwaukee):

Provide two levels of on-site training for the Downtown Complex Facilities Management staff and tenants.

1. On-Site Training:

a. Factory certified trainer to provide training for managers, engineers, mechanics, electricians, and technicians.

b. Service representative to provide operations and maintenance training.

2. Training Hours and Frequency:

a. Level I:

To be provided upon the completion of the project. Training will be a 2 hour minimum administered on-site. Level I training is administered to the tenant, managers, engineers, mechanics, electricians, technicians, and others who

interact with equipment, hardware, software, and facilities maintenance.

b. Level II:

Two hour segment once per year. This training serves as both a review and a systems development preview.

F. Verification and Validation of Training:

1. An outline of the training and test materials shall be provided to the City's facility O & M Manager two weeks prior to the training sessions. Corrections, additions, and deletions will be at the discretion of the O & M Manager within a week of receiving the test. All written materials, graphs, cue cards, trainer's notes, and phone numbers will accompany the outline for preview.

2. A ½ hour test shall be provided to the City's operations staff. This test shall be given after each of the HVAC equipment, HVAC controls, and fire protection and life/safety (fire alarms) systems Level I on-site training sessions. This test shall include written true and false, essay questions, and hands-on field work performance.

G. Materials:

1. An edited videotape of the training will be provided.

2. All prepackaged videotapes, training software, and textbooks from the manufacturer, specific to the training, will be provided.

H. At the submittal stage, 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.

I. The manual shall include manufacturer's instructions for maintenance and operation and shall be completely indexed, including the spare parts list.

J. Submit three (3) final copies in hardbound cover and one (1) electronic copy (pdf) to DPW, ISD - Bridges and Buildings Section.

K. Contractor shall provide to the City a video recording (DVD) of all equipment installed under this contract. Tape shall be provided prior to the installation of any ceilings.

L. Contractor shall video record (DVD) one training session and turn over to the City for future reference.

TECHNICAL SPECIFICATIONS

SECTION 02 41 19
SELECTIVE STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.

B. Related Requirements:

1. Division 01 Section "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Division 01 Section "Execution" for cutting and patching procedures.
3. Division 31 Section "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

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.

1.6 INFORMATIONAL SUBMITTALS

1. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for dust control. Indicate proposed locations and construction of barriers.

B. 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 building managers and other tenants' on-site operations are uninterrupted.

2. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 FIELD 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.

1. Before selective demolition, Owner will remove the following items:

a. `

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

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

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

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

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

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

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

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

1. Comply with requirements specified in Division 01 Section "Photographic Documentation."

3.2 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.

1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."

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.

3.3 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. 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.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. 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.

5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management and Disposal."

3.4 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: 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.

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. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weather tight. See Division 07 for new roofing requirements.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

3.5 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.

3.6 CLEANING

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

END OF SECTION

SECTION 04 22 00
CONCRETE UNIT MASONRY

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 cutting & patching of concrete masonry units. (Not governed by structural)
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Miscellaneous masonry accessories.

B. Related Sections:

1. Division 02 Section "Selective Non-Structure Demolition"

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

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

1.4 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

1.6 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.

b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

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, from single source from 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 single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.8 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.

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 use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

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

1.9 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

B. 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.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Regional Materials: CMUs shall be manufactured within 500 miles (800 km) of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units for outside corners unless otherwise indicated.

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi (19.3 MPa).
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Size (Width): Manufactured to the following dimensions:
5. 200 mm nominal;
6. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

2.3 CONCRETE AND MASONRY LINTELS

A. General: Unless indicated otherwise by structural documents, provide one of the following:

B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than CMUs.

C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 MORTAR AND GROUT MATERIALS

A. Regional Materials: Aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

B. Portland cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

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

D. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.

E. Aggregate for Grout: ASTM C 404.

F. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Mill galvanized, carbon steel.
2. Wire Size: 0.148-inch (3.77-mm) diameter.
3. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
4. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Interior Walls: Mill galvanized, carbon steel.

B. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch- (1.52-mm-) thick, steel sheet, galvanized after fabrication.

a. 0.108-inch- (2.74-mm-) thick, galvanized sheet may be used at interior walls unless otherwise indicated.

2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.25-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.

3. Corrugated Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 12.7 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from 0.060-inch- (1.52-mm-) thick, steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch (25 mm) of masonry face.

a. 01.08-inch- (2.74-mm-) thick, galvanized sheet may be used at interior walls unless otherwise indicated.

C. Partition Top anchors: 0.105-inch- (2.66-mm-) thick metal plate with 3/8-inch- (9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from hot-dip galvanized after fabrication.

D. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.35 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.7 MISCELLANEOUS ANCHORS

A. Postinstalled Anchors: Torque-controlled expansion anchors or chemical anchors.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

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

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication.

2.9 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. Use portland cement-lime or mortar cement mortar unless otherwise indicated.

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

C. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

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

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

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: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

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

H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

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

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.

3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.9 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.10 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar

and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 12.67 ft. (3.86 m).

3.11 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, where indicated.

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 nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.12 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Excess Masonry Waste: Remove excess clean masonry waste, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 05 55 00
MISCELLANEOUS METAL FABRICATIONS

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. Steel framing and supports for applications where framing and supports are not specified in other Sections.
2. Selective cutting & patching of existing security ceiling assembly

B. Related Sections:

1. Division 02 Section "Selective Non-Structure Demolition"

1.3 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

B. Delegated Design:

1. Design Loads: Dead & live loads transmitted to framing by pipe hangers & saddles are indicated on drawings.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

a. Horizontal deflection no less than 1/360 of the horizontally projected span.
b. Framing beams & columns for mechanical piping only. No other building dead or live loads to be superimposed onto metal fabrication.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

C. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.

D. Steel Tubing: ASTM A 500, cold-formed steel tubing.

E. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 1 (A1).

D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

F. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Furnish inserts for units installed after concrete is placed.

C. Galvanize all exterior miscellaneous framing and supports.

D. Unless noted otherwise prime all miscellaneous framing and supports with zinc-rich primer. Primer compatible with mill finish steel or galvanized steel.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize all exterior items and items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. All exterior metal fabrications to be hot dipped galvanized unless noted otherwise.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 06 10 53
MISCELLANEOUS ROUGH CARPENTRY

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. Wood blocking, cants, and nailers.
2. Wood furring and grounds.

B. Related Requirements:

1. Division 02 Section "Selective Non-Structure Demolition"

1.3 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NHLA: National Hardwood Lumber Association.
2. NLGA: National Lumber Grades Authority.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

B. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawl spaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

E. Application: Treat items indicated on Drawings:

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Cants.
4. Furring.
5. Grounds.

B. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber of any species.

C. For concealed boards, provide lumber with 19 percent maximum moisture content of any species.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM a 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening to Metal Framing: ASTM C 1002, 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: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

2.6 METAL FRAMING ANCHORS

A. Hot-Dip Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.

2.7 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. 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, grounds, and similar supports to comply with requirements for attaching other construction.

B. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

C. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

E. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

F. Do not splice structural members between supports unless otherwise indicated.

G. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

H. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.

2. Use copper naphthenate for items not continuously protected from liquid water.

J. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

K. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD GROUND, BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or 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.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 07 59 10
PREPARATION FOR REROOFING

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. Partial tear-off of roof areas indicated.
2. Re-cover preparation of roof areas indicated.
3. Removal of base flashings.
4. Temporary roofing.

B. Related Requirements:

1. Section 01 "Summary" for use of the premises and phasing requirements.
2. Section 01 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for reroofing preparation.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

B. Roof Re-Cover Preparation: Existing roofing system is to remain and be prepared for new roof installed over it.

C. Partial Roof Tear-Off: Removal of selected components and accessories from existing roofing system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, and details.

C. Temporary Roofing Submittal: Product data and description of temporary roofing system. If temporary roof remains in place, include surface preparation requirements needed to receive permanent roof, and submit a letter from roofing manufacturer, stating acceptance of the temporary roof and that its inclusion does not adversely affect the roofing system's resistance to fire and wind or its FM Global rating.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1. Include certificate that Installer is approved by warrantor of existing roofing system.

B. Landfill Records: Indicate receipt and acceptance of demolished roofing materials by a landfill facility licensed to accept them.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Approved by warrantor of existing roofing system to work on existing roofing and licensed to perform asbestos abatement in the state or jurisdiction where Project is located.

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

1.7 FIELD CONDITIONS

A. Existing Roofing System: Ballasted Elastomeric "rubber roofing".

B. Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so Owner's operations are not disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.

1. Coordinate work activities daily with Owner so Owner can place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.
2. Before working over structurally impaired areas of deck, notify Owner to evacuate occupants from below affected area. Verify that occupants below work area have been evacuated before proceeding with work over impaired deck area.

C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.

D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

E. Conditions existing at time of inspection for bidding are maintained by Owner as far as practical.

1. Construction Drawings and Project Manual for existing roofing system are provided for Contractor's convenience and information, but are not a warranty of existing conditions. They are intended to supplement rather than serve in lieu of Contractor's own investigations. Contractor is responsible for conclusions derived from existing documents.

F. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

1. Remove only as much roofing in one day as can be made watertight in the same day.

G. Hazardous Materials: It is not expected that hazardous materials, such as asbestos-containing materials, will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work. Existing roof will be left no less watertight than before removal.
2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

1.8 WARRANTY

H. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty. Notify warrantor before proceeding.

PART 2 - PRODUCTS

2.1 TEMPORARY PROTECTION MATERIALS

A. Expanded Polystyrene (EPS) Insulation: ASTM C 578.

B. Plywood: DOC PS1, Grade CD Exposure 1.

2.2 TEMPORARY ROOFING MATERIALS

A. Design and selection of materials for temporary roofing are Contractor's responsibilities.

2.3 INFILL AND REPLACEMENT MATERIALS

A. Use infill materials matching existing roofing system materials unless otherwise indicated.

2.4 RE-COVER BOARDS

A. Re-Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate; 1/2 inch (13 mm), factory primed

B. Fasteners: Factory-coated steel fasteners, No. 12 or No. 14, and metal or plastic plates listed in FM Global's "Approval Guide," designed for fastening re-cover boards to deck and acceptable to new roofing system manufacturer.

2.5 AUXILIARY REROOFING MATERIALS

A. General: Use auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing and new roofing system.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shut off rooftop utilities and service piping before beginning the Work.

B. Test existing roof drains to verify that they are not blocked or restricted. Immediately notify Architect of any blockages or restrictions.

C. Protect existing roofing system that is not to be reroofed.

1. Limit traffic and material storage to areas of existing roofing 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.

D. 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.

E. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.

F. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

1. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing roofing system components that are to remain.

3.2 ROOF TEAR-OFF

A. General: Notify Owner each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.

B. Remove loose aggregate from roofing using a manual broom.

C. Remove ballast, protection mat, and extruded-polystyrene insulation from protected roofing membrane.

1. Discard extruded-polystyrene insulation that is damaged or exceeds 8 lb/cu. ft. (128 kg/cu. m).

D. Partial Roof Tear-Off: Where indicated, remove existing roofing and immediately check for presence of moisture by visually observing substrate that is to remain.

1. Coordinate with Owner's inspector to schedule times for tests and inspections immediately after removal.
2. With an electrical capacitance moisture-detection meter, spot check substrate that is to remain.
3. Remove wet or damp materials below existing roofing and above deck.
4. Inspect wood blocking, curbs, and nailers for deterioration and damage. If wood blocking, curbs, or nailers have deteriorated, immediately notify Architect.
5. Remove fasteners from deck or cut fasteners off slightly above deck surface.

3.3 DECK PREPARATION

A. Inspect deck after tear-off of roofing system.

B. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 or by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under plastic sheet or if asphalt test sample foams or can be easily and cleanly stripped after cooling.

C. If deck surface is unsuitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Architect. Do not proceed with installation until directed by Architect.

3.4 INFILL MATERIALS INSTALLATION

A. Immediately after roof tear-off, and inspection and repair, if needed, of deck, fill in tear-off areas to match existing roofing system construction.

B. Install new roofing patch over roof infill area. If new roofing is installed the same day tear-off is made, roofing patch is not required.

3.5 TEMPORARY ROOFING

A. Install approved temporary roofing over area to be reroofed.

B. Remove temporary roofing before installing new roofing.

C. Prepare temporary roof to receive new roofing by patching and repairing temporary roofing. Restore temporary roofing to watertight condition. Obtain approval for temporary roof substrate from roofing manufacturer and Architect before installing new roof.

3.6 ROOF RE-COVER PREPARATION

A. Remove blisters, ridges, buckles, mechanically attached roofing fastener buttons projecting above roofing, and other substrate irregularities from existing roofing that inhibit new re-cover boards from conforming to substrate.

1. Remove loose aggregate from roofing using a manual broom.
2. Broom clean existing substrate.
3. Coordinate with Owner's inspector to schedule times for tests and inspections before proceeding with installation of re-cover boards.
4. Verify that existing substrate is dry before proceeding with installation of re-cover boards. Spot check substrates with an electrical capacitance moisture-detection meter.
5. Remove materials that are wet or damp. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.

3.7 BASE FLASHING REMOVAL

A. Remove existing base flashings. Clean substrates of contaminants.

B. Do not damage metal counterflashings that are to remain. Replace metal counterflashings damaged during removal with counterflashings of same metal, weight or thickness, and finish."

C. Inspect parapet sheathing, wood blocking, curbs, and nailers for deterioration and damage. If parapet sheathing, wood blocking, curbs, or nailers have deteriorated, immediately notify Architect.

D. Remove existing parapet sheathing and replace with new parapet sheathing to comply with Section 06160 "Sheathing." If parapet framing, wood blocking, curbs, or nailers have deteriorated, immediately notify Architect.

3.8 RE-COVER BOARD INSTALLATION

3.9 DISPOSAL

A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

1. Storage or sale of demolished items or materials on-site is not permitted.

B. Transport and legally dispose of demolished materials off Owner's property.

END OF SECTION

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. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Sections:

1. Division 07 Section "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, and in smoke barriers.

1.3 ACTION SUBMITTALS

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

B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
   a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
   b. Classification markings on penetration firestopping correspond to designations listed by the following:
      (1) UL in its "Fire Resistance Directory."

D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. A/D Fire Protection Systems Inc.
2. Grace Construction Products.
3. Hilti, Inc.
4. 3M Fire Protection Products.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is 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. Penetration

firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Fire-resistance-rated walls include smoke-barrier walls and fire partitions.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Horizontal assemblies include floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:
    a. Slag-wool-fiber or 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.

2.3 FILL MATERIALS

A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

B. 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.

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 the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with 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 penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. 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 manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming 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 firestopping.

C. Install fill materials for firestopping 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 the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner may engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping 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 penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SCHEDULE

A. As noted on drawings & details. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory".

B. Firestopping as required for rated partitions & shaft assemblies.

C. Firestopping as made by and for MEP penetrations into & through rated partitions, are by MEP respective trades.

D. Firestopping into & through rated partitions, made by GC, as noted on drawings & details are by GC.

END OF SECTION

SECTION 20 0500
BASIC REQUIREMENTS FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic mechanical requirements specifically applicable to Divisions 20, 21, 22, and 23.

1.2 DEFINITIONS

A. The following words or phrases have special meaning when used in the article (of the division and in any other requirement) applicable to this discussion:

1. "Exposed to View" or "Exposed" — shall have reference to and mean that the pipes, ducts, etc., insulated or otherwise, in the completed structure are visible within any normally occupied space, room or area.
2. "In Concealed Spaces", "Concealed or "Not Exposed to View" — shall have reference to and mean that the pipes, duct, etc., insulated or otherwise are concealed and not exposed to view within furred spaces, above suspended ceilings, pipe chases, etc.
3. "Unfinished Spaces" or "Unfinished Rooms" — shall have reference to areas such as Machine Rooms, Equipment Rooms, or similar areas. Where the words "In Finished Areas" or "Finished Rooms" are used, it shall have reference to rooms or spaces, such as, Reading rooms, Offices, Public Corridors, etc.
4. "Finished Rooms or Spaces" shall refer to areas similar to offices, public corridors, and public toilet rooms.
5. "Provide" — shall be taken to mean "furnish and install" meaning to purchase and deliver to the job site and the installation thereof.
6. "Piping" — shall include, in addition to pipe all fittings, valves, hangers, and other supports, expansion compensators, anchors, and accessories related to such piping including associated insulation.
7. "Ductwork" — shall include, in addition to ducts, all fittings, transitions, dampers, hangers and other supports, fire dampers, access panels, associated insulation and accessories related to such ductwork.
8. "Contractor" in Specifications and Drawing refers to respective Contractor performing that portion of work.
9. "Invert Elevation" (I.E.) means elevation of inside bottom of pipe or duct.
10. "Mechanical Work" is work in Divisions 20, 21, 22, and 23.

NOTE: The words "Contractor shall" are implied and shall be so understood wherever the directions "furnish," "install" or "provide" are used.

1.3 SPECIAL CONDITIONS

A. Minor items and accessories or devices reasonably inferable as necessary to the complete and proper operation of any system shall be provided by the Contractor for such system whether or not they are specifically called for by the Specifications or Drawings.

B. Where work specified in other sections of the specifications connects to equipment specified in Divisions 20, 21, 22, and 23 Sections, check the required connection to such equipment.

1.4 WORK BY OWNER

A. Refer to Division 01

1.5 OWNER-FURNISHED PRODUCTS

A. Refer to Division 01.

1.6 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Owner before proceeding.

1.7 CONTRACTORS' USE OF PREMISES

A. Refer to General Conditions and Division 01.

B. The Owner will be responsible for the identification and abatement of all hazardous materials and asbestos associated with the project. Although great care will be taken to eliminate any risks, the Contractor must be aware that hazardous materials may exist on site. Therefore, the Contractor shall immediately suspend work and notify the Owner if asbestos or other hazardous material is suspected in the work area of the project.

1.8 WORK SEQUENCE

A. Refer to General Conditions and Division 01.

1.9 FUTURE WORK

A. Refer to General Conditions and Division 01.

1.10 SUMMARY OF PROJECT

A. Refer to General Conditions and Division 01.

1.11 ALLOWANCES

A. Refer to General Conditions and Division 01.

1.12 UNIT PRICES

A. Refer to General Conditions and Division 01.

1.13 ALTERNATES

A. Refer to General Conditions and Division 01.

1.14 REFERENCE STANDARDS

A. Refer to General Conditions and Division 01.

1.15 SUBMITTALS

A. Refer to General Conditions and Division 01.

1.16 PROPOSED PRODUCTS LIST

A. Refer to General Conditions and Division 01.

1.17 CONTRACTOR-PREPARED SHOP DRAWINGS

A. Refer to General Conditions and Division 01.

1.18 PRODUCT DATA

A. Refer to General Conditions and Division 01.

1.19 SAMPLES

A. Refer to General Conditions and Division 01.

1.20 MANUFACTURER'S INSTRUCTIONS

A. Refer to General Conditions and Division 01.

1.21 MANUFACTURER'S CERTIFICATES

A. Refer to General Conditions and Division 01.

1.22 QUALITY CONTROL SERVICES

A. Refer to General Conditions and Division 01.

1.23 MANUFACTURER'S FIELD SERVICES AND REPORTS

A. Refer to General Conditions and Division 01.

1.24 CONTRACT CLOSEOUT

A. Closeout Procedures

1. Refer to General Conditions and Division 01.

B. Final Cleaning

1. Refer to General Conditions and Division 01.

C. Adjusting

1. Refer to General Conditions and Division 01.

D. Project Record Documents

1. Refer to General Conditions and Division 01.

1.25 O&M DATA

A. Quality Assurance

1. Refer to General Conditions and Division 01.

B. Format

1. Refer to General Conditions and Division 01.

C. Contents, Each Volume

1. Refer to General Conditions and Division 01.

D. Manual for Materials and Finishes

1. Refer to General Conditions and Division 01.

E. Manual for Equipment and Systems

1. Refer to General Conditions and Division 01.

F. Instruction of Owner Personnel

1. Refer to General Conditions and Division 01.

G. Submittals

1. Refer to General Conditions and Division 01.

H. Warranties

1. Refer to General Conditions and Division 01.

1.26 REGULATORY REQUIREMENTS

A. Conform to International Mechanical Code 2009 with alterations in State of Wisconsin SPS 364., State of Wisconsin Plumbing Code SPS 382 and NFPA 13, latest editions.

B. Obtain permits and request inspections as required.

C. Conform to all other governing agencies and authorities

PART 2 - PRODUCTS

2.1 MATERIAL AND EQUIPMENT

A. Refer to General Conditions and Division 01.

2.2 STORAGE AND PROTECTION

A. Refer to General Conditions and Division 01.

2.3 PRODUCT OPTIONS

A. Refer to General Conditions and Division 01.

2.4 SUBSTITUTIONS

A. Refer to General Conditions and Division 01.

PART 3 - EXECUTION

3.1 SCOPE

A. Work included under Divisions 20, 21, 22, and 23 shall include all labor, services, materials and equipment and performance of all work required for installation of mechanical, plumbing, and fire suppression systems as shown on Drawings and as herein specified in following sections.

3.2 INTERPRETATION OF CONSTRUCTION DOCUMENTS

A. Should there be discrepancy or a question of intent, refer matter to Engineer for decision before ordering any equipment or materials or before starting any related work.

B. Drawings and Specifications are to be taken together. Work specified and not shown or work shown and not specified shall be performed or furnished as though mentioned in both Specifications and Drawings. If there is discrepancy between Drawings and Specifications as to quantity or quality to be provided, the greater quantity or better quality shall be provided.

C. Minor items and accessories or devices reasonably inferable as necessary to complete and proper installation and operation of any system shall be provided by Contractor for such system whether or not specifically called for by Specifications or Drawings.

D. Engineer may change location of any equipment 5′ and any piping, ductwork, conduit, etc. 10′ in any direction without extra charge, provided such changes are made before installation.

E. Locations of items not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site and shall be subject to review and approval by Architect.

F. Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed, and maintain maximum headroom and space conditions at all points.

1. Where headroom or space conditions appear inadequate, notify Architect or Owner's field representative before proceeding with installation.
2. Duct and pipe rerouting and duct size changes shall be made at no additional cost to the Owner.

G. Furnish advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit installation of other work without delay.

H. Where there is evidence that parts of the Work specified in Divisions 20, 21, 22, and 23 will interfere with other work, assist in working out space conditions to make satisfactory adjustments, revise and submit coordinated shop drawings.

I. After review and without additional cost to the Owner, make minor modifications in the work as required by structural interferences, by interferences with work of other sections or for proper execution of the work.

J. Work installed before coordinating with other work so as to cause interference with other work shall be changed and corrected without additional cost to the Owner.

K. Drawings are diagrammatic in nature and are a graphic representation of requirements and shall be followed as closely as actual building construction will permit. All changes from the plans necessary to make the work conform to the building as constructed and to fit the work of other trades or to conform to rules of the Governmental Authorities having jurisdiction, NFPA, OSHA and the Owner's Insurance Underwriters, shall be made by the Contractor without extra cost to the Owner.

L. The layout of the piping, ductwork, equipment, etc., as shown on the drawings shall be checked and exact locations shall be determined by the dimensions of the equipment approved and the Contractor shall obtain approval for the revised layout before the apparatus is installed. The Contractor shall field measure or consult existing record Architectural and Structural Drawings if available for all dimensions, locations of partitions, locations and sizes of structural supports, foundations, etc.

M. Omission in the Drawings and/or Specifications of any items necessary for the proper completion or operation of the work outlined in this specification shall not relieve the Contractor from furnishing same without additional cost to the Owner.

N. The Equipment Shop Drawings will be furnished to the Contractor before roughing-in. Contractor shall not install any piping or ductwork for said equipment until he has received approved shop drawings for same.

3.3 PROJECT/SITE CONDITIONS

A. Each Contractor shall visit the site prior to bid submission to determine all existing conditions that may affect his work and shall make appropriate allowances for such conditions in his bid. Failure to visit the site shall not be cause for a request for additional compensation later in the project during construction.

B. Install Work in locations shown on Drawings, unless prevented by Project conditions.

C. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Engineer before proceeding.

3.4 ALTERATIONS IN PRESENT BUILDING AND SYSTEMS

A. Contractor shall take particular note of the revisions and alterations to the existing systems, facilities and equipment due to the new construction as indicated on the Drawings and/or in Specification. Contractor shall remove, reroute or alter all services, ductwork, etc., as required or as indicated on the drawings.

1. The Contractor shall maintain all services in the existing building. In case, where new service connections are to be made to existing services and service

interruptions can in no way be avoided, the service interruptions shall be with the minimum of inconvenience to the Owner and the work shall be done at such time of any day, Saturday and Sunday included, and only as directed by the Owner or the Architect.

3.5 ERECTION & WORKMANSHIP

A. Contractor is to be responsible for all work fitting into place in satisfactory, neat and workmanlike manner in every particular, to approval of Engineer.

B. Unless explicitly stated to contrary, each Contractor shall furnish and install each item of equipment or material hereinafter specified, complete with all necessary fittings, supports, trim, piping, insulation, etc., as required for complete and operating installation.

C. Equipment and materials shall be installed according to manufacturer's instruction unless otherwise specifically directed by Contract Documents.

D. Contractor shall provide all necessary OSHA approved rigging, scaffolding, tools, tackle, labor, etc., necessary for the complete installation of the equipment.

E. Contractor shall adapt his work to job conditions and make such changes as required and permitted by the Architect such as moving his work to clear beams, joints, light fixtures, etc., adjusting risers, etc. avoiding interferences with windows and openings, etc. raising or lowering his work to permit the passing of ductwork or the work of other trades, etc., all as required or as job conditions dictate, without any additional costs to the Owner.

F. All appliances and equipment shall be installed and connected with best engineering practices and in accordance with the manufacturer's best instructions and recommendations.

G. Work done by Contractor at the site in the execution of this Project shall be performed only by skilled mechanics, recognized as such in their respective trades in the direct employ either of the Contractor proper or of affiliate firms which have a longstanding and continuing formal agreement with the Contractor for providing the rendered services on similar work of this type.

3.6 PROTECTION FROM INJURY

A. All pipes, fixtures, traps, equipment, and other parts of the Work shall be protected against injury by freezing or exposure to the weather during construction while stored or installed in place.

3.7 MECHANICAL AND ELECTRICAL WORK COORDINATION

A. Refer to General Conditions and Division 01.

3.8 CUTTING AND PATCHING

A. Refer to General Conditions and Division 01.

3.9 ACCESS PANELS

A. Where control valves, shutoff valves, drip traps, heating coils, dampers, pull boxes or other specialties, which require service or adjustment, are installed above inaccessible type furred ceilings or within furred walls, Contractor whose equipment is involved shall furnish and install access panels as required.

B. Access panels shall be of sufficient size to make possible servicing, adjustment, removal and replacement of concealed equipment through opening provided. Panels shall be

sized as shown on drawings, or if sizes are not shown, shall be minimum of 16" x 24" in walls and 24" x 24" in ceilings.

C. Contractor shall confer with other trades with respect to access panel locations and shall, wherever practical, group valves, traps, dampers, etc. in such way as to be accessible from single panel and eliminate as many access panels as possible.

D. Submit shop drawings for review before ordering panels. Where fire rating is required, furnish label doors compatible with fire rating of assembly.

3.10 SOUND CONTROL

A. Piping, ductwork, etc. shall pass through sleeves tightly packed with glass fiber or oakum and caulked on both sides with non-hardening acoustical sealant. Refer to Division 20 Section 20 0529, "Supports, Anchors, and Sleeves for Mechanical, Plumbing, and Fire Suppression."

3.11 FIRE RATED PENETRATIONS

A. Sleeves for pipes and ducts through fire rated and fire resistive floors and walls shall be constructed of materials classified by UL to provide fire stopping equal to time rating of construction being penetrated. Use asbestos free materials that comply with applicable codes and have been tested under positive pressure in accordance with UL 1479 or ASTM E 814.

B. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.

C. Seal holes or voids made be penetrations to ensure an effective smoke barrier.

D. Where floor openings without penetrating items are more than 4" in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor.

E. Protect materials from damage on surfaces subject to traffic.

F. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

G. Keep areas of work accessible until inspection by applicable code authorities.

H. Perform under this section patching and repairing of fire stopping caused by cutting or penetration by other trades.

I. Clean up spills of liquid components.

J. Neatly cut and trim materials as required.

K. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.12 PROTECTION OF ELECTRICAL EQUIPMENT

A. Contractor shall furnish and install sheet metal drain pans beneath piping that is routed above electrical equipment and/or above the 3' access space in front of such equipment. Electrical equipment, for the purpose of addressing drain pan requirements, shall be defined as free-standing or wall-mounted switchgear, transformers, distribution boards or motor control centers. Piping includes, but is not limited to, plumbing, fire suppression, mains (not branch piping with sprinkler heads), hydronic heating or cooling, steam and condensate, and fuel systems.

1. Drain pans shall be 20 gauge galvanized sheet metal with a minimum 4" high turned up edge. Bottom of drain pan shall slope to a single drainage point at ⅛"

per foot. A 1" diameter clear plastic tube shall allow collected fluid to drain to the nearest open site floor drain. Secure plastic tubing to building structure only.

2. Drain pan shall be hung from building structure with angle iron trapeze hangers (no hanger shall penetrate the drain pan). Consider drain pan to be full of water for hanger load calculations.
3. Drain pans shall include liquid detectors with alarms only if noted on the drawings.

B. Provide sprinkler heads beneath drain pan only as required by NFPA.

C. Contractor shall include provisions to adjust the local lighting layout, at no extra cost to Owner, in order to accommodate any detrimental effect the drain pan has on the illumination of the electrical equipment and access space.

3.13 STARTING OF SYSTEMS

A. Refer to General Conditions and Division 01.

3.14 TESTING, ADJUSTING AND BALANCING

A. Contractor shall appoint, employ and pay for services of independent firm to perform testing, adjusting and balancing.

B. Independent firm will perform services specified in Division 23 Section 23 0593, "Testing, Adjusting, and Balancing for HVAC," except for factory tests.

C. Reports will be submitted by independent firm to Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with requirements of Contract Documents.

3.15 ALTERATION PROJECT PROCEDURES

A. Refer to General Conditions and Division 01.

3.16 DEMONSTRATIONS AND INSTRUCTIONS TO OWNER PERSONNEL

A. Refer to General Conditions and Division 01.

END OF SECTION

SECTION 20 0501
MINOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Minor demolition specifically applicable to Divisions 20, 21, 22, 23, 27, and 28.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Refer to General Conditions and Division 01.

B. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field measurements, equipment location, piping and ductwork sizes and arrangements as shown on Drawings.

B. Verify that abandoned piping, ductwork and equipment serve only abandoned facilities.

3.2 PREPARATION

A. Disconnect mechanical systems in walls, floors and ceilings scheduled for removal.

B. Coordinate utility service shut-downs with Utility Companies.

C. Provide temporary connections to maintain existing systems in service during construction.

D. Existing Mechanical Systems: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and new connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize shut-down duration.

3.3 DEMOLITION AND EXTENSION OF EXISTING SYSTEMS

A. Demolish and extend existing work under provisions of General Conditions, Division 01 and this Section.

B. In general, mechanical, plumbing, fire suppression, medical gas, and electrical remodeling work is shown on Drawings but carefully study all drawings for all contracts for “demolition” and “remodeling” work in existing building and field check to verify locations where such work is being done to determine exact extent of work required. No extra will be allowed for additional work required because of demolition or remodeling whether or not work is specifically noted, itemized or shown on Drawings.

C. Remove existing equipment and materials pertaining to contract as specified or as required, whether shown on Drawings or not, to prepare for new work of all contracts.

D. Where necessary, reroute piping, ducts, etc. from within walls, floors, ceilings, etc. being removed. Contractor involved with interrupted service shall be responsible for accomplishing required work whether shown on Drawings or not.

E. Cap all abandoned or terminated piping, etc. below floor, behind wall surface, above ceiling, etc., as required to be completely concealed after new work is complete.

F. Cap or plug all pipes, valves, fittings, etc. left open after demolition if they are not to be reused.

G. Maintain access to existing mechanical installations which remain active. Modify installation or provide access panel as appropriate.

H. Extend existing installations using materials and as specified.

3.4 DISPOSITION OF REMOVED EQUIPMENT

A. Where existing materials or equipment are specified to be removed from service, respective Contractor shall take possession of same, coordinate with Owner where items are to be stored or remove unwanted items from site promptly, except as specified below or unless otherwise noted on Drawings.

B. All salvageable material and equipment, including but not necessarily limited to plumbing fixtures, heating units, air conditioning units, piping, valves, etc., shall be removed and maintained in as good condition as possible and turned over to Owner. However, if Owner decides any such materials are of no value to him, then they shall become property of Contractor who shall remove such discarded work from premises and dispose of same.

C. Existing equipment or systems, etc. which are specified to be replaced by new equipment, or system etc. shall not be removed from service until the new equipment, materials, systems, etc. have actually arrived at project site.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 01.

3.6 CLEANING AND REPAIR

A. Refer to General Conditions and Division 01.

B. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION

SECTION 20 0513
MOTOR REQUIREMENTS FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Motor requirements specifically applicable to Divisions 20, 21, 22, and 23, including:

1. Single-phase general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 volts.
2. Three-phase general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 volts.

B. Coordination

1. Coordinate features of motors, installed units, and accessory devices to be compatible with the following such that all items furnished constitute a properly related package:
   a. Motor starters
   b. Motor controllers
   c. Variable frequency drives
   d. Torque, speed and horsepower requirements of the load
   e. Ratings and characteristics of supply circuit and required control sequence
   f. Ambient and environmental conditions of installation location
2. Providing a motor to satisfy the efficiency requirements specified herein, is the responsibility of the Contractor. If any given manufacturer or supplier of the motorized equipment cannot provide a motor that satisfied the specified efficiency requirements, the Contractor is responsible for any and all steps necessary to provide an adequate motor including but not necessarily limited to:
   a. Coordinating delivery and installation of an acceptable motor to the motorized equipment supplier for factory-installation.
   b. Field-installation of an acceptable motor on the motorized equipment. Field installation shall not void the warranty of the motorized equipment.

1.2 DEFINITIONS

A. Factory-installed motor: A motor installed by the motorized equipment manufacturer at the equipment manufacturer's factory as a component of the equipment.

B. Field-installed motor: A motor installed on the motorized equipment at the Project site.

1.3 CODES AND STANDARDS (UTILIZE LATEST EDITION)

A. ASHRAE 90.1- Energy Standard for Buildings except Low-Rise Residential Buildings

B. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

C. ANSI/IEEE 112B - Test Procedure for Polyphase Induction Motors and Generators

D. EISA - The Energy Independence and Security Act of 2007

E. IECC - International Energy Conservation Code

F. IEEE 112-2004 - Standard Test Procedure for Polyphase Induction Motors and Generators

G. IEEE 841-2001 - Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp)

H. NETA ATS - Acceptance Testing Specification

I. NFPA 70 - National Electrical Code

J. NEMA MG 1- Motors and Generators

K. UL 1004 – Electric Motors

1.4 QUALITY ASSURANCE

A. Manufacturer shall be a company specializing in manufacture of electric motors for the intended use and their accessories, with minimum three years documented product development, testing and manufacturing experience.

B. All motors shall be UL 1004 listed.

C. Motor efficiencies shall be based on the IEEE 112, Test Method B.

1.5 SUBMITTALS

A. Product Data

1. Submit manufacturer's literature indicating:
    a. Type and size of motor
    b. Name plate data and rating
    c. Weight
    d. Conduit entry and ground lug locations
    e. Enclosure type and mounting arrangement
    f. Insulation class
    g. Information on coating or finishes
    h. Nominal minimum efficiency
        (1) Provide statement that all motors 1 hp and larger meet "premium efficiency" requirements specified herein.
    i. Nominal minimum power factor
    j. Sound power levels in dba
2. Submit manufacturer's test results verifying guaranteed minimum efficiency and power factor for all three phase motors larger than 1 hp.
3. Submit manufacturer's installation instructions.
4. Submit manufacturer's literature for bearing protection grounding rings. If not integral to the motor supplied, but field installed as an option, also provide manufacturer's installation instructions.

B. Operating and Maintenance Data

1. Submit operation and maintenance data.
2. Include assembly drawings, bearing data (including replacement sizes) and lubrication instructions.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site.

B. Protect motors stored on-site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 SPARE PARTS

Not Applicable.

1.8 WARRANTY

A. Provide five year manufacturer's warranty for motors equal to or larger than 1 hp.

PART 2 - PRODUCTS

2.1 MOTORS

A. Acceptable Manufacturers

1. Baldor Electric
2. Emerson Motors
3. Lincoln
4. Marathon Electric
5. Siemens
6. TECO – Westinghouse

B. General Motor Requirements Applicable to All Motors

1. Comply with the requirements in this section except when stricter requirements are specified on the drawings or Division 23 Equipment Sections.
2. Comply with NEMA MG 1.
3. Motor Size:
   a. Motors shall be capable of driving the intended load and not exceeding the design horsepower.
   b. Motors shall be selected such that the brake horsepower (bhp), including drive losses of the driven equipment, does not exceed 90% of the motor nameplate rating at design conditions.
4. Visible Nameplate:
   a. Provide a visible motor nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, and service factor.
   b. Nameplates for all three-phase motors shall also indicate power factor and efficiency.
   c. Nameplate shall indicate "Premium Efficiency" where such a motor is provided.
5. Motor Characteristics:
   a. Duty Rating:
      (1) Continuous duty at ambient temperature of 104°F (40°C) and at altitude of 3,300 feet above sea level.
      (2) Motors shall be capable of not less than six (6) starts in a twenty-four (24) hour period.
   b. Capacity and Torque Characteristics:

(1) 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 service factor.

6. Enclosures:

a. Enclosure Material:

(1) Cast iron for motor frame 25 hp and larger.
(2) Rolled steel for motor frame sizes smaller than 25 hp.

b. Open drip proof (ODP) for indoor locations not in an airstream.
c. Totally enclosed fan cooled (TEFC) for all motors located within an airstream including within air handling unit housings, ducted airstreams, and ceiling or floor air plenums.
d. Motors located in exterior locations shall be TEFC with weatherproof cover.

(1) Totally enclosed air over (TEAO) motors are acceptable for cooling tower applications provided they meet the efficiency requirements of the TEFC motors.

C. Three Phase Motors

1. Efficiency:

a. Motor efficiencies shall at a minimum comply with the most recent editions of the International Energy Conservation Code and ASHRAE Standard 90.1.
b. All general purpose, three-phase motors from 1 hp up to 200 hp driving Division 21, 22, and/or 23 specified equipment (e.g. stand-alone fans, fans within air handling units, heating hot water pumps, chilled water pumps, domestic water pumps shall be premium efficiency and meet the minimum efficiencies specified in the following table:

	Totally Enclosed, Fan Cooled Motors			Open, Drip-Proof Motors		
hp	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	87.5	86.5	84.0	86.5	86.5	84.0
2	88.5	86.5	85.5	87.5	86.5	85.5
3	89.5	89.5	86.5	88.5	89.5	85.5
5	89.5	89.5	88.5	89.5	89.5	86.5

2. Service Factor

a. Per the following NEMA Service Factor Table

HP	900 rpm	1200 rpm	1800 rpm	3600 rpm
1/6 to 1/3	1.35	1.35	1.35	1.35
½	1.15	1.25	1.25	1.25

¾	1.15	1.15	1.25	1.25
1	1.15	1.15	1.15	1.25
1½ to 150	1.15	1.15	1.15	1.15

b. Do not take advantage of service factors in selection of motors.

3. Rotor: Random-wound, squirrel cage.
4. Bearings:
   a. Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 150,000 hours for direct-coupled applications and 50,000 hours for belted applications. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
   b. Motors not installed in horizontal position shall be provided with suitable bearings.
   c. Grease fittings shall be provided. Both fittings and drain plugs shall be fully accessible while the motor is in operation. Where motors are installed in an inaccessible location, the grease fitting shall be extended to an accessible location. High pressure hydraulic steel tubing and fittings shall be used.
5. Temperature Rise and Insulation:
   a. Motors smaller than 1 hp: NEMA Class B temperature rise with Class B insulation.
   b. Motors 1 hp and larger: NEMA Class B temperature rise with Class F insulation.
6. Starting Code Designation:
   a. Motors smaller than 15 hp: Manufacturer's standard starting characteristics.
   b. Motors 15 hp and larger: NEMA starting Code F or Code G.
7. Motor windings shall be first grade copper.

D. Additional Requirements for Three Phase Motors Used with Variable Frequency Drives
1. Motor shall be "inverter-ready" by complying with or exceeding the NEMA MG1 Part 31 requirements regarding special purpose motors for use with variable frequency drives.
2. Windings shall be 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.
3. Motors shall be equipped with shaft grounding ring(s) to dissipate potential VFD-induced motor shaft currents by grounding through the motor housing.
   a. Provide one (1) grounding ring per motor.
   b. Provide solid ring or split ring, based on grounding ring manufacturer's recommendations.
   c. Shaft grounding brushes or insulated bearings are not acceptable.
   d. Shaft Grounding Rings shall be factory-installed or field-installed by the motor manufacturer or field-installed by the contractor.

e. Acceptable Product: Aegis SGR Bearing Protection Ring as manufactured by Electric Static Technology.
f. This provision for grounding devices shall not apply to motors used in environments defined as Class 1 Division 1, Division 2, or Class 1 Zone 1, Zone 2 hazardous locations.

E. Additional Requirements for Motor Driven Equipment Located Outdoors

1. Epoxy seal windings using vacuum and pressure with rotor and stator surfaces protected with epoxy enamel.
2. Bearings shall be double shielded with waterproof non-washing grease.
3. Provide weatherproof enclosure for motor.

F. Single Phase Motor

1. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   a. Permanent-split capacitor
   b. Split phase
   c. Capacitor start, inductor run
   d. Capacitor start, capacitor run
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. 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.
6. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

PART 3 - EXECUTION

3.1 APPLICATION

A. Electrical Service

1. Motors ¾ hp and larger shall operate on 480 or 208 volt, three-phase 60 Hertz, alternating current, except as otherwise noted.
2. Motors smaller than ¾ hp shall operate on 120 volt, single-phase, 60 Hertz, alternating current, except as otherwise noted.

B. Motor speed shall not exceed 1,750 rpm unless otherwise specified.

3.2 INSTALLATION

A. Factory Installed Motors

Not used

B. Field Installed Motors

1. Examine area to receive field installation for compliance with required tolerances and other conditions affecting performance. Examine roughing-in of conduit

systems to verify actual locations. Correct any deficiencies found during examination.

2. Anchor motor assembly to base, adjustable rails or other support according to manufacturers' instructions. Level and align.
3. Perform testing of motor after installation:
    a. Run each motor. Demonstrate correct rotation, alignment and speed.
    b. Test interlocks and control features for proper operation.
    c. Verify that current in each phase is within nameplate rating.
    d. Perform an acceptance test in accordance with NETA Acceptance Testing Specification, Section 7.15.1. Certify compliance with test parameters.
    e. Correct any deficiencies found by test and repeat acceptance test.
4. Clean motors according to manufacturers' written instructions.

C. Field Installed Bearing Protection Rings

1. Verify applicable maximum and minimum temperature and humidity allowances with manufacturer's technical support.
2. Based on motor application, motor size, motor frame, and bearing types, use shaft grounding ring kit that corresponds to shaft grounding ring manufacturer's installation recommendations and instructions.
3. Based on manufacturer's installation instructions, clean the motor shaft and other motor surfaces to remove any coatings, paint or other nonconductive material to prepare all conducting surfaces.
4. Perform pre-installation Ohms test:
    a. Place the positive and negative meter leads on the shaft at a place where the grounding ring fibers will contact the shaft. Each motor will have a different reading but in general you should have a maximum reading of 2 ohms. If the reading is higher than 2 ohms, provide additional cleaning retest.
5. Apply conductive shaft surface coating per manufacturer's recommendations and installation instructions.
6. As required by the installation and per manufacturer's recommendations and installation instructions:
    a. Drill and tap installation holes in the motor end bracket per manufacturer's installation instructions.
    b. Apply manufacturer supplied adhesive and hold in place until the adhesive sets.
7. Perform post-installation testing:
    a. Perform Ohms test to verify conductive path to ground using ohm meter. Place one probe on metal frame of grounding ring and one probe on the motor frame. NOTE: Motor must be grounded to common earth ground with drive according to application standards.

END OF SECTION

SECTION 20 0517
PENETRATIONS FOR MECHANICAL, PLUMBING, AND FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Sleeve and sleeve seal for penetration through walls, floors, and roofs, specifically applicable to Divisions 20, 21, 22, and 23 including:

1. Pipe sleeves and sleeve seals for pipe penetrations
2. Duct sleeves for duct penetrations
3. Firestopping
4. Flashing

1.2 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between, and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 CODES AND STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B31.1: Power Piping
2. ASME B31.9: Building Service Piping Code
3. ASME B36.10: Welded and Seamless Wrought Steel Pipe

B. American Society for Testing and Materials (ASTM):

1. ASTM A53: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

C. National Fire Protection Association (NFPA):

1. NFPA 13: Installation of Sprinkler Systems
2. NFPA 14: Installation of Standpipe and Hose Systems

D. Underwriters Laboratories Inc. (UL):

1. UL 203: Pipe Hanger Equipment for Fire Protection Service
2. UL 1479: Fire Tests of Through-Penetration Firestops

1.4 SUBMITTALS

A. Product Data: Submit product data on all sleeves and fire stopping materials. Product data to include, but not limited to materials, finishes, approvals, and dimensional information.

1.5 DELIVERY, STORAGE AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

PART 2 - PRODUCTS

2.1 PIPE SLEEVES AND SLEEVE SEALS FOR PIPE PENETRATIONS

A. Non-Fire Rated Walls

1. Schedule 40 standard weight steel pipe or 18 gauge galvanized sheet steel sleeve
2. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

B. Non-Fire Rated Floor

1. Schedule 40 standard weight steel pipe sleeve
2. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Non-Fire Rated Wet Floor

1. Schedule 40 galvanized steel pipe sleeve
2. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Fire Rated Walls

1. Provide an approved penetration firestop system installed as tested in accordance with UL 1479 with an F rating of not less than the required rating of the wall penetrated.

E. Fire Rated Floors

1. Provide an approved penetration firestop system installed as tested in accordance with UL 1479 with an F rating and T rating of not less than the required rating of the floor penetrated.

F. Smoke Rated Walls and Floors

1. Provide an approved firestop penetration system installed as tested in accordance with UL 1479 with an L rating of not more than 5 cfm/sq. ft. at both ambient and elevated temperature.

G. Foundation Walls and Below Grade Walls

1. Walls

a. Sleeve: Heavy wall welded or seamless steel pipe with 2″ steel water stop. Model WS steel sleeve by Thunderline Corporation.

b. Sleeve seal: Modular, mechanical seal consisting of rubber links shaped to continuously fill the annular space between the pipe and the wall opening. Pressure plates shall be of molded glass reinforced nylon. Hardware shall be mild steel with a 60,000 psi minimum tensile strength and zinc dichromate coating. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve or opening, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall opening. The seal shall be constructed so as to provide electrical insulation between the pipe and wall, thus reducing changes of cathodic reaction between these two members. Model C Link-Seal modular seal by Thunderline Corporation.

H. Roof

1. Plumbing vent stack sleeve fitting: Vent stack flashing sleeve; lacquered, coated cast iron body with adjustable combination membrane flashing flange and clamp. Basis of Design: Zurn Model Z-195-10.
2. All other penetrations: Provide and install a pipe penetration roof curb as specified in Division 20 Section "Hangers and Supports."

2.2 DUCT SLEEVES FOR DUCT PENETRATIONS

A. Non-Fire Rated Walls

1. Field formed 18 gauge galvanized steel sleeve.
2. Size sleeves large enough to provide for continuous insulation wrapping.

B. Non-Fire Rated Floors and Wet Floors

1. Field formed 18 gauge galvanized steel sleeve.
2. Size sleeves large enough to provide for continuous insulation wrapping.

C. Fire Rated Walls Not Requiring a Fire Damper

1. Provide an approved penetration firestop system installed as tested in accordance with UL 1479 with an F rating of not less than the required rating of the wall or floor penetrated.

D. Fire Rated Walls Requiring a Fire Damper

1. Provide and install the fire damper as required by UL and the manufacturer. Refer Division 20 Section "Ductwork Accessories."

E. Smoke Rated Walls

1. Provide and install the smoke damper as required by UL and the manufacturer. Refer to Division 20 Section "Ductwork Accessories."

F. Roof – Provide and install a duct penetration roof curb as specified in Division 20 Section "Hangers and Supports."

2.3 FIRE STOPPING

A. Approved Manufacturers

1. Hilti
2. 3M

B. Provide firestopping products that are compatible with one another, with the substrates forming openings, and with the items penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by firestopping products manufacturer based on testing and field experience.

C. Provide components for each firestopping system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

D. Use only firestopping products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type or joint opening width and movement capabilities, annular space requirements, and fire-rating involved for each separate instance.

E. Performance Requirements

1. Provide products that upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric

moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.

2. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.
3. Pipe and duct insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
4. Penetrants passing through fire-resistance rated floor-ceiling assemblies contained within chase wall assemblies shall be protected with products tested by being fully exposed to the fire outside of the chase wall. Systems within the UL Fire Resistance Directory that meet this criterion are identified with the words "Chase Wall Optional".
5. Provide through-penetration firestop systems subjected to an air leakage test conducted in accordance with the Standards, ANSI/UL1479 for penetration and ANSI/UL2079 for joint systems, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the firestop system to restrict the movement of smoke.
6. Provide T-Rating Collar Devices tested in accordance with ASTM E-814 or ANSI/UL1479 for metallic pipe penetrations requiring T-Ratings per the applicable building code.

F. Materials

1. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No. 1168.
2. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.4 FLASHING

A. Built-up Bituminous Membrane Roof Flashing

1. Composition Flashing System: Composition flashing system shall be by the same manufacturer as the roofing system, and shall be asphalt-saturated and coated felt, reinforced with woven cotton fabric.
2. Flashing Cement: Bituminous product expressly recommended by the roofing materials manufacturer for flashing work on vertical surfaces, asphaltic flashing cement or flashing compound of troweling consistency.
3. Fabric Reinforcement: Asphalt-saturated cotton fabric, treated with asphaltic resin, meeting requirements of ASTM D173, or woven glass fabric, treated with asphalt resin, meeting requirements of ASTM D1668, as applicable.
4. Bituminous Plastic Cement: Asphaltic plastic cement, meeting requirements of ASTM D2822 or D4586.

B. Modified Bituminous Membrane Roof Flashing

1. Provide sheet flashings, preformed inside and outside corner sheet flashings, in-seam sealants, and other accessories compatible with roofing membrane and recommended by roofing system manufacturer for specified system, fire resistance, and warranty.

C. Elastomeric Membrane Roof Flashing

1. Flexible Flashing Material: Same material as membrane.

a. Thickness: 60 mil
b. Color: Match membrane

PART 3 - EXECUTION

3.1 ABOVE GROUND PENETRATION INSTALLATION

A. Set sleeves in position in formwork. Provide reinforcing around sleeves. All sleeves shall be set true to line, level, plumb and position.

B. Where insulated ducts or pipes which pass through sleeves, the sleeves shall be of sufficient size to permit the full specified thickness of insulation to pass through sleeves.

C. Where piping or ductwork penetrates floors, extend sleeves through the floor 1" above finished floor level. Pack the annular space with fiberglass insulation and caulk air tight. Provide a chrome-plated steel escutcheon cover at both sides of the penetration.

D. Where piping or ductwork penetrates wet floors extend sleeves through the floor 2" above finished floor level. Pack the annular space with fiberglass insulation and caulk water tight. Provide a chrome-plated steel escutcheon cover at both sides of the penetration.

E. Wet floor areas include:

1. Kitchens
2. Toilet Rooms
3. Showers
4. Laboratories
5. Equipment Rooms

F. Where piping or ductwork penetrates fire rated floors, ceilings, or walls, all pipe and duct penetrations shall installed per an applicable UL fire rated assembly. Contractor shall provide documentation of the UL assembly utilized for each type of penetration at close out.

G. The contractor shall not drill holes through, cut or otherwise damage any beam or column of the building's structural frame.

3.2 PENETRATIONS THROUGH FOUNDATION WALLS AND BELOW GRADE WALLS

A. Determine the required inside diameter of each individual wall opening or sleeve before ordering, fabricating or installing. The inside diameter of each wall opening shall be sized as recommended by the manufacturer to fit the pipe and seal to provide a water tight joint. Sizing (correct seal model and number of links per seal) may be obtained through manufacturer's catalog. If pipe O.D. is non-standard due to coating, insulation, etc., consult manufacturer for recommendation before proceeding with wall opening detail.

B. Mechanical Contractor shall familiarize his installing personnel with manufacturers Seal instruction bulletin which should illustrates the proper procedure for installing and tightening the seal to provide a water-tight pipe penetration.

C. Support piping independently of link seal. Refer to Division 20 Section "Hangers and Supports."

3.3 FIRE RATED PENETRATION INSTALLATION

A. Apply fire stopping material in strict accordance with manufacturer's specific UL system number.

B. Provide identification label for each penetration stating UL system number, date of installation, installing company name, and rating number.

C. Penetration shall be free of debris and dirt.

D. Dam the penetration (when required) with an acceptable material.

E. Apply material to the penetration. Use a caulking gun, putty knife or other normal trade tools per manufacturer's instructions.

F. Provide proper material thickness to assure that fire rating is equal to or greater than floor or wall pipe is penetrating.

3.4 FLASHING

A. Built-up Bituminous Roof Flashing

1. Flashing shall be installed at junctures in the roofing system; in the angles formed where the roof deck abuts curbs, ventilators, pipes, and other vertical surfaces; and where necessary to make the work watertight; and in accordance with the membrane manufacturer's requirements and recommendations.
2. Outlets: Properly seal drains, outlets, and penetrations in accordance with roofing manufacturer's specifications and as indicated.
3. Pipes, vents, gravel stops, and flashings: Install flanges of such items on top of last roofing ply in full bed of plastic cement 1/4" thick. Flanges shall then be covered with two additional plies of felt, 4" and 6" inches respectively, in full bed of plastic cement, feathered onto roofing.
4. Flashing systems shall consist of an approved system of the roofing materials manufacturer, and shall be applied over flat portion of roof perimeters and extended up over cant strips and up sloping and vertical surfaces fully height to under metal counterflashings. Roof flashings shall be left in watertight condition by applying plastic cement to any and all areas not yet covered by metal flashings or counterflashings.
5. Apply fabric reinforcement in hot asphalt or plastic cement at transitions, over joints, cracks, and other surfaces where fabric reinforcement is required or recommended.

B. Modified Bituminous Membrane Roof Flashing

1. Sheet Flashing: Apply modified bitumen sheet flashing matching the roofing system in the angles formed where the roof deck abuts curbs, ventilators, pipes, and other vertical surfaces, and where necessary to make the work water tight, and in accordance with the membrane manufacturer's requirements and recommendations. Install using hot asphalt. Seal flashings and flanges of items penetrating the roof membrane with two plies of sheet flashing.

C. Elastomeric Membrane Roof Flashing

1. Use roofing manufacturers pre-molded flashings to the greatest extent possible. Where not possible, obtain manufacturers recommended flashing detail requirements in writing.

3.5 CLEANING

A. Clean sleeves with fire, smoke and fume stopping materials as follows.

1. Remove damming materials where necessary after material has cured.
2. Clean up adjacent surfaces with Xylene or other approved cleaning agent.

END OF SECTION

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SECTION 20 0529
HANGERS AND SUPPORTS FOR MECHANICAL, PLUMBING AND FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Hangers and supports specifically applicable to Divisions 20, 21, 22, and 23, including:

1. Pipe Hangers and Supports
2. Duct Hangers
3. Equipment Hangers and Supports
4. Upper Attachments
5. Multiple Pipe Supports
6. Hanger Rods
7. Roof Supports
8. Miscellaneous materials

1.2 CODES AND STANDARDS

A. American Society of Mechanical Engineers (ASME)

1. ASME B31.1 - Power Piping
2. ASME B31.5 - Refrigeration Piping
3. ASME B31.9 - Building Services Piping

B. American Society for Testing and Materials (ASTM)

1. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability *(Formerly ASTM A570)*
2. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
3. ASTM A36 - Steel Plates, Shapes and Bars
4. ASTM A653 - Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process
5. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
6. ASTM C150 - Portland Cement
7. ASTM C404 - Uniformly Graded Natural Sand
8. ASTM E-814 - Fire Tests of Through-Penetration Fire Stops

C. American Welding Society (AWS)

1. Specifications for Qualification of Welding Procedures and Welders

D. American Water Works Association (AWWA)

E. Building Officials and Code Administrators International (BOCAI)

1. BOCA - National Building Code
2. BOCA - National Mechanical Code

F. International Conference of Building Officials (ICBO)

1. ICBO - Uniform Building Code

G. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices

H. National Fire Protection Association (NFPA)

1. NFPA 13 - Standard for the Installation of Sprinkler Systems
2. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems
3. NFPA 101 - Code for Safety to Life from Fires in Buildings and Structures

I. Southern Building Code Congress International (SBCCI)

1. SBCCI - Standard Building Code

J. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA - HVAC Duct Construction Standards, Metal and Flexible

K. UL

1. UL 1479 - Fire Tests of Through Penetration Firestops and Building Joint Systems

L. Factory Mutual (FM)

1.3 QUALITY ASSURANCE

A. Supports for Mechanical and Plumbing Piping: Provide products in compliance with MSS Standards:

1. Provide pipe hangers and supports of which materials, design and manufacture comply with MSS SP-58.
2. Select and apply pipe hangers and supports, complying with MSS SP-69.
3. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
4. Terminology used in this section is defined in MSS SP-90.

B. Supports for Sprinkler Piping: Provide products which are UL listed and FM approved and in conformance with NFPA 13.

C. Supports for Standpipes: Provide products which are UL listed and FM approved and in conformance with NFPA 14.

D. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.4 SUBMITTALS

A. Product Data: Submit product data on all hanger and support devices, including shields and attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.5 DELIVERY, STORAGE AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Acceptable Manufacturers

1. B-Line Systems, Inc.
2. Fee and Mason Manufacturing Company
3. Anvil International

B. Construction

1. General Service

a. Interior insulated pipe: Carbon steel with plain electro-galvanized finish
b. Exterior insulated pipe: Carbon steel with hot-dip galvanized finish after fabrication
c. Interior uninsulated steel, cast iron, ductile iron and plastic pipe: Carbon steel with plain primer finish.
d. Exterior uninsulated steel, cast iron, ductile iron and plastic pipe: Carbon steel with hot-dip galvanized finish after fabrication
e. Interior uninsulated copper pipe: Carbon steel with copper plated or epoxy coated finish
f. Exterior uninsulated copper pipe: Carbon steel with copper plated or epoxy coated finish
g. Interior glass pipe: Carbon steel with plastic or vinyl coated finish

C. Piping system classification

1. Type A-1 Hot Systems (120°F - 450°F)

a. Refrigerant Gas

2. Type C-1 Cold Systems (33°F - 59°F)

a. Refrigerant Suction
b. Condensate

D. Pipe supports shall be provided as indicated the table below.

Pipe Hanger and Support MSS Types – Part 1									
Class		A-1				B			
Pipe Size		≤2″		>2″		≤2″		>2″	
Insulation[1]		Yes	No	Yes	No	Yes	No	Yes	No
Horizontal Pipe Attachments	Steel Clips	24 w/ 39	24 & 26	24 w/ 39	24 & 26	24 & 26	24 & 26	24 & 26	24 & 26
	Malleable Iron Rings	N/A	6, 11, &12	N/A	6, 11, &12	N/A	6, 11, &12	N/A	6, 11, &12
	Steel Bands	1 w/ 40	1	1 w/ 39	1	1 w/ 40	1	1 w/ 40	1
	Steel Clamps	2 & 3	3 & 4	2 & 3	3 & 4	3 & 4	3 & 4	3 & 4	3 & 4
	Cast Iron Hanging Rolls	N/A	N/A	41 & 43 w/ 39	41 & 43	N/A	N/A	41 & 43 w/ 39	41 & 43
	Cast Iron Supporting Rolls	N/A	N/A	44, 45, & 46 w/ 39	44, 45, & 46	N/A	N/A	44, 45, & 46 w/ 39	44, 45, & 46
	Steel Trapezes	59 w/ 40	59	59 w/ 39	59	59 w/ 40	59	59 w/ 39	N/A
	Steel Protection Saddles and Shields	39 & 40	N/A	39	N/A	40	N/A	39	N/A
	Steel or Cast Iron Stanchions	36, 37, & 38 w/ 40	36, 37, & 38	36, 37, & 38 w/ 39	36, 37, & 38	36, 37, & 38 w/ 40	36, 37, & 38	36, 37, & 38 w/ 39	36, 37, & 38
	Steel Welded Attachments	35[2]		35[2]		35[2]		35[2]	

(1) *Hangers on insulated systems shall incorporate protection saddles or shields or shall be clamped or welded to the pipe and project through the insulation to provide external attachment.*

(2) *The design shall be in accordance with MSS SP-58.*

Pipe Hanger and Support MSS Types – Part 2									
Class		C-1				C-2			
Pipe Size		≤ 2″		> 2″		≤ 2″		> 2″	
Insulation[1]		Yes	No	Yes	No	Yes	No	Yes	No
Horizontal Pipe Attachments	Steel Clips	26 w/40	24 & 26	26 w/ 40	24 & 26	N/A	N/A	N/A	N/A
	Malleable Iron Rings	N/A	6, 11, & 12	N/A	6, 11, & 12	N/A	N/A	N/A	N/A
	Steel Bands	1 w/ 40	1	1 w/ 40	1	1 w/ 40	1	1 w/ 40	1
	Steel Clamps	3 & 4	3 & 4 w/ 40	3 & 4	3 & 4 w/ 40	N/A	3 & 4	N/A	3 & 4
	Cast Iron Hanging Rolls	N/A	N/A	41 & 43 w/ 40	41 & 43	N/A	N/A	41 & 43 w/ 40	41 & 43
	Cast Iron Supporting Rolls	N/A	N/A	44, 45, & 46 w/ 39	44, 45, & 46	N/A	N/A	44, 45, & 46 w/ 39	44, 45, & 46
	Steel Trapezes	59 w/ 40	N/A	59 w/ 40	N/A	N/A	N/A	N/A	N/A
	Steel Protection Saddles and Shields	40	N/A	40	N/A	40	N/A	40	N/A
	Steel or Cast Iron Stanchions	36, 37, & 38 w/ 40	36, 37, & 38	36, 37, & 38 w/ 40	36, 37, 38	36, 37, & 38 w/ 40	36, 37, 38	36, 37, & 38 w/ 40	36, 37, 38
	Steel Welded Attachments	[2]		[2]		[2]		[2]	

(1) *Hangers on insulated systems shall incorporate protection saddles or shields or shall be clamped or welded to the pipe and project through the insulation to provide external attachment.*

(2) *The design shall be in accordance with MSS SP-58.*

Pipe Hanger and Support MSS Types – Part 3						
Class			A-1	B	C-1	C-2
Vertical Pipe Attachments		Steel Riser Clamps (2 Bolt)	8	8	8	8
		Steel Riser Clamps (4 Bolt)(1)	42	42	42	42
Hanger Rod Fixtures	Steel or Malleable Iron	Turn Buckles	13 & 15	13 & 15	13 & 15	13 & 15
		Swing Eyes	16 & 17	16 & 17	16 & 17	16 & 17
		Clevises	14	14	14	14
Building Structure Attachments	Steel and/or Malleable Iron	Inserts(2)	18	18	18	18
		C-Clamps(3)	19 & 23	19 & 23	19 & 23	19 & 23
		Beam Clamps(4)	20, 21, 25, 27, 28, 29, & 30	20, 21, 25, 27, 28, 29, & 30	20, 21, 25, 27, 28, 29, & 30	20, 21, 25, 27, 28, 29, & 30
		Welded Attachments(1)	22, 57, & 58	22, 57, & 58	22, 57, & 58	22, 57, & 58
		Brackets	31, 32, 33, & 34	31, 32, 33, & 34	31, 32, 33, & 34	31, 32, 33, & 34

(1) *The design shall be in accordance with MSS SP-58.*

(2) *Refer to 2.7 – Upper Attachments for approved inserts.*

(3) *All C-Clamps shall be provided with a retaining strap held securely to the clamp with a hex nut of locking slot. C-Clamps shall not be used with bar joist structure.*

(4) *Clamps for direct attachment to bar joist structure shall be MSS Type 21 center beam clamp located at the plates along the bottom or top chord of the joist.*

2.2 DUCT HANGERS

A. Threaded Rod Type

1. Duct hangers shall be strips of galvanized steel or round steel rod and shall comply with SMACNA - HVAC Duct Construction Standards, Metal and Flexible.
2. Trapeze and Riser Supports:
   a. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates
   b. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates
   c. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate

3. Attachments: Equipment support shall be directly attached to the building structure utilizing an upper attachment or by utilizing a building structure attachment as indicated in the Pipe Hanger and Support MSS Types – Part 3 table as specified in Division 20 Section "Hangers and Supports for Mechanical, Plumbing, Medical Gas, and Fire Suppression."

B. Cable Type

1. Approved Manufacturers
   a. Gripple
   b. Duro Dyne
2. Cable type duct hangers shall be an engineered manufactured product supplied as a complete duct hanging system by the manufacturer.
3. Cable type duct hangers shall be provided and installed according to the manufacturer's recommendations.
4. Cable Lock
   a. Cable locks shall have an ultimate breaking strength of at least 5 times the published working load limit.
   b. Cable locks shall be constructed of zinc alloy for interior use and stainless steel for exterior use.
   c. Cable locks shall be suitable for use up to 300°F.
5. Cable
   a. Wire rope shall be galvanized steel of 3/16" or 1/8" diameter.
   b. All wire rope shall have an ultimate breaking strength of at least 5 times the published working load limit.
6. Duct Trapeze
   a. Duct trapeze bracket shall include a cable lock which fastens to the duct utilizing sheet metal screws.
   b. Duct trapeze bracket shall have an ultimate breaking strength of at least 5 times the published working load limit.
7. Upper Attachments
   a. Stud
      (1) Zinc coated steel threaded rod stud for connection of cable to building structure.
      (2) Stud shall be connected to structure by screwing into a drop-in anchor set in concrete structure or by screwing into a C-clamp (MSS Type 19 or 23) or beam clamp (MSS Types 20, 21, 25, 27, 28, 29, or 30) attached to steel structure.
      (3) Stud shall have an ultimate breaking strength of at least 5 times the published working load limit.
   b. Loop
      (1) Loop cable around building structure and lock utilizing cable lock.

2.3 EQUIPMENT HANGERS AND SUPPORTS

A. Equipment Pads

1. Pads shall be nominal 4" high and shall extend a minimum of 4" beyond all equipment and supports while generally conforming to the shape of the equipment.
2. Pads shall be minimum 2500 psi (28 day) concrete reinforced with No. 6 – 6"x6" welded wire mesh. Pad tops and sides shall be hard troweled smooth with a ¾" bull nose on all external corners. Refer to Division 03 for additional requirements.
3. Furnish galvanized anchor bolts with layout templates for installation in equipment pads. Bolts shall be of the size and quantity recommended by the manufacturer and where vibration isolators are used, they shall be anchor bolted to the equipment pad.
4. Equipment mounted to pads shall be provided with vibration isolation supports indicated in Division 20 Specification "Vibration Isolation for Mechanical, Plumbing, and Fire Suppression"

B. Hanging Equipment

1. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
2. Structural Steel: ASTM A36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
3. Attachments: Equipment support shall be directly attached to the building structure utilizing an upper attachment or by utilizing a building structure attachment as indicated in the Pipe Hanger and Support MSS Types – Part 3 table as specified in Division 20 Section "Hangers and Supports for Mechanical, Plumbing, Medical Gas, and Fire Suppression."
4. Hanging equipment shall be provided with vibration isolation hangers indicated in Division 20 Specification Vibration Isolation for Mechanical, Plumbing, and Fire Suppression.

2.4 UPPER ATTACHMENTS

A. Concrete Inserts

1. Continuous
   a. Approved Manufacturers
      (1) B-Line Systems, Inc.
      (2) Fee and Mason Manufacturing Company
      (3) Anvil International
      (4) Unistrut
   b. MSS type 18 12 gauge ASTM A1011 SS Grade 33 structural carbon steel cast in place channel with styrofoam insert and end caps with nail holes for attachment to forms.
2. Adjustable Spot
   a. Approved Manufacturers
      (1) B-Line Systems, Inc.

(2) Fee and Mason Manufacturing Company
(3) Anvil International

b. MSS type 18 malleable iron spot cast in place insert with lateral adjustment
c. MSS type 18 12 gauge ASTM A1011 SS Grade 33 structural carbon steel cast in place channel with styrofoam insert and end caps with nail holes for attachment to forms

3. Spot

a. Approved Manufacturers

(1) Cooper B-Line
(2) Hilti
(3) Powers

b. Color coded, six sided cast in place wood knocker insert with nails for attachment to forms, capable of accepting threaded rod from ¼" to ¾" in diameter

B. Concrete and Masonry Drilled In Anchors

1. Wedge Anchor

a. Approved Manufacturers

(1) ITW Red Head
(2) Hilti
(3) Powers

b. Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193.
c. Anchor shall be listed with ICC-ES.
d. Interior Use: Carbon steel anchors with zinc plating
e. Exterior Use: Stainless steel anchors of AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
f. Basis of Design: Hilti Kwik Bolt 3

2. Screw Anchors

a. Approved Manufacturers

(1) ITW Red Head
(2) Hilti
(3) Powers

b. Screw type: Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be

done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head.

c. Anchor shall be listed with ICC-ES.
d. Interior Use: Carbon steel anchors with zinc plating
e. Basis of Design: Hilti Kwik-Hus

3. Drop-in Anchor

a. Approved Manufacturers

(1) ITW Red Head
(2) Hilti

b. Drop-in, shell type internally threaded anchor with expansion cone insert and flush embedment lip
c. Anchor shall be listed with ICC-ES.
d. Interior Use: Carbon steel anchors with zinc plating
e. Exterior Use: Stainless steel
f. Anchors shall be listed by ICC-ES
g. Basis of Design: Hilti HDI

C. Metal Deck

1. Metal Deck with Concrete Topping on Structural Steel: Support hangers from 1 ½″ x 1 ½″ x 1/8″ x 12″ long angles set on deck over holes drilled in deck and across corrugations, before pouring of concrete topping or from beam clamps fastened to structural steel
2. Metal Deck on Beams: Support hangers from clamps fastened to beams or to auxiliary steel between beams
3. Metal Deck on Bar Joist: Support hangers from MSS type 21 center beam clamps fastened at the plates along the top or bottom chord or to auxiliary steel between bar joists

D. Precast Concrete

1. Precast Concrete with Concrete Topping or Roof Insulations: Support hangers from 4″ x 4″ x ¼″ thick drilled steel plates set on deck over drilled holes before pouring of concrete topping or placing of roof insulation or from cinch anchors located in the precast deck

2.5 MULTIPLE PIPE SUPPORT SYSTEMS

A. Acceptable Manufacturers

1. Cooper B-Line
2. Anvil International
3. Unistrut Corporation

B. Multiple Pipe Supports: Pipe supporting elements mounted to cold formed 12 gauge strip steel channel framing with thermoset acrylic finish. Provide specified pipe supporting elements to keep pipe in alignment and allow for expansion. Provide all channel nuts and accessories required to mount pipe supporting elements. Model P1000 by Unistrut.

C. Strut type trapeze hangers shall be limited to copper tubing systems less than 2″ diameter and selected for maximum deflection of 1/4″.

D. Provide tubing clamps at each pipe support. Provide cushion inserts for uninsulated tubing.

E. Select hanger rods for two times the trapeze loads but not less than 3/8" diameter.

F. Secure hanger rod with square washers and locking nuts on top and bottom of strut.

2.6 HANGER RODS

A. Hanger Rods for Dry or Non-corrosive Environments: Cadmium-plated steel rods and nuts, continuously threaded.

B. Hanger Rods for Moist or Corrosive Environments: Electrogalvanized continuously threaded rods or hot dipped galvanized rods with threads painted with zinc-chromate primer after installation.

2.7 ROOF SUPPORTS

A. Equipment Rail Support

1. Acceptable Manufacturers:
   a. Pate
   b. Thybar
2. Factory fabricated 18 gauge galvanized sheet steel structural members with internal bulkheads spaced to provide high load-bearing capacity of roof mounted equipment
3. Support shall incorporate a continuous 2x4 treated wood nailer covered by a removable counter flashing to allow for water tight roofing installation.
4. Support shall be designed to be compatible with roofing system and roofing pitch.

B. Roof Equipment Support

1. Acceptable Manufacturers:
   a. Pate
   b. Thybar
2. Factory fabricated 18 gauge galvanized sheet steel curb with full mitered corners, fully welded seams, continuous 2x2 pressure treated wood nailer, and factory installed 1½" thick, 3 pounds per cubic foot density rigid insulation
3. Support shall be designed to be compatible with roofing system and roofing pitch.
4. Roof support shall be 18" minimum high above roofing surface.

C. Multiple pipe penetration curb

1. Acceptable Manufacturers:
   a. Pate
   b. Thybar
2. Factory fabricated 18 gauge galvanized sheet steel curb with full mitered corners, fully welded seams, continuous 2x2 pressure treated wood nailer, and factory installed 1½" thick, 3 pounds per cubic foot density rigid insulation.
3. Support shall be designed to be compatible with roofing system and roofing pitch.
4. EPDM compression molded rubber cap for single or multiple pipes as required.

5. Stainless steel draw-band clamps.

D. Duct penetration curb

1. Acceptable Manufacturers:
   a. Pate
   b. Thybar
2. Factory fabricated 18 gauge galvanized sheet steel curb with full mitered corners, fully welded seams, continuous 2x2 pressure treated wood nailer, and factory installed 1½" thick, 3 pounds per cubic foot density rigid insulation.
3. 6" high 18 gauge galvanized sheet steel curb adapter reducer with fully mitered corners and fully welded seams and 1½" thick, 3 pounds per cubic foot density rigid insulation shall be provided to adapt the size of the roof curb to the size of the duct penetrating the roof. A foam gasket seal shall be provided between the roof curb and curb adapter reducer.
4. A 20 gauge galvanized sheet metal collar counterflashed to the curb adapter reducer with a continuous seal of mastic or foil back tape at the duct penetration-collar joint.
5. Support shall be designed to be compatible with roofing system and roofing pitch.

E. Permanent pipe support

1. Acceptable Manufacturers:
   a. Pate PRS/MPRS
2. Factory fabricated 18 gauge galvanized sheet steel support curb with fully welded corner seams, 2x4 pressure treated wood nailer, and 18 gauge galvanized steel counterflashing with galvanized steel channel track attached.
3. Vertical and horizontal adjustable roller assembly of galvanized steel channel track, galvanized steel fittings, washers and nuts and a painted cast iron roller.
4. Support shall be designed to be compatible with roofing system and roofing pitch.

F. Permanent duct support

1. Acceptable Manufacturers:
   a. Pate DSS/MDSS
2. Factory fabricated 18 gauge galvanized sheet steel support curb with fully welded corner seams, 2x4 pressure treated wood nailer, and 18 gauge galvanized steel counterflashing with galvanized steel channel track attached.
3. Vertical and horizontal adjustable duct mounting assembly of galvanized steel channel track, galvanized steel fittings, washers and nuts.
4. Support shall be designed to be compatible with roofing system and roofing pitch.

G. Temporary pipe and duct support

1. Acceptable Manufacturers:
   a. Cooper B-Line
2. Adjustable Height Roller

a. Up to 3-1/2" pipe size

(1) UV resistant rubber base with two ½" galvanized steel threaded rod risers and adjustable height electroplated cast iron MSS type 41 pipe roll with sockets. Cooper B-Line DBR.

b. 4" and greater pipe size

(1) Roof support: Four UV resistant rubber bases with two 12 gauge galvanized steel channel base supports, two 12 gauge galvanized steel channel risers, and one 12 gauge galvanized steel horizontal channel support. Cooper B-Line DB_DS.

(2) Pipe support: Electroplated cast iron MSS type 41 pipe roll with sockets

3. Fixed Height Roller

a. UV resistant rubber base with fixed height electroplated cast iron MSS type 44 pipe roll. Cooper B-Line DBR.

4. Adjustable Height Channel

a. Roof support: UV resistant rubber base with two ½" galvanized steel threaded rod risers and one 12 gauge galvanized steel horizontal channel support. Cooper B-Line DBE.

b. Pipe support: Electroplated cast iron MSS type 44 pipe roll

5. Fixed Height Channel

a. Roof support: UV resistant rubber base with fixed height 12 gauge galvanized steel horizontal channel support. Cooper B-Line DB6.

b. Pipe support: Electroplated cast iron MSS type 44 pipe roll

H. Temporary duct support

1. Acceptable Manufacturers:

a. Cooper B-Line

2. Four UV resistant rubber bases with two 12 gauge galvanized steel channel base supports, two 12 gauge galvanized steel channel risers, and one 12 gauge galvanized steel horizontal channel support. Cooper B-Line DB_DS.

2.8 MISCELLANEOUS MATERIALS

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 PIPE HANGERS AND SUPPORTS

A. Hanger and Support Installation

1. 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.
2. 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.
    a. 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.
    b. 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.
3. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
4. Fastener System Installation:
    a. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
    b. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
5. Pipe Stand Installation:
    a. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
    b. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.
6. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
7. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
8. 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.
9. Install lateral bracing with pipe hangers and supports to prevent swaying.
10. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, 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.
11. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

12. 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.

B. Hanger and Support Spacing

1. Pipe shall be adequately supported by pipe hanger and supports specified in Part 3. Hangers for insulated pipes shall be sized to accommodate insulation thickness.
2. Horizontal steel piping shall be supported in accordance with MSS SP-69 Tables 3, 4, and 5, excerpts of which follow below:

Maximum Horizontal Pipe Hanger and Support Spacing Without MSS Type 40 Shields (feet)

Nominal Pipe or Tube Size	Standard Weight Steel Pipe		Copper Tube		Fire Protection	Ductile Iron Pipe	Cast Iron Soil	Glass	Plastic
	Water Service	Vapor Service	Water Service	Vapor Service					
1/4	7	8	5	5	Follow requirements of the NFPA.	20 feet maximum spacing; minimum of one hanger per pipe section close to the joint behind the bell and at change of direction and branch connections. For pipe sizes six inches and under subjected to loadings other than weight of pipe and contents, the span shall be limited to the maximum spacing for water service steel pipe.	10 feet maximum spacing; minimum of one hanger per pipe section close to joint on the barrel and at change of direction and branch connections.	8 feet maximum spacing, follow manufacturer's recommendations.	Follow pipe manufacturer's recommendations for material and service condition.
3/8 – 1/2	7	8	5	6					
3/4	7	9	5	7					
1	7	9	6	8					
1-1/4	7	9	7	9					
1-1/2	9	12	8	10					
2	10	13	8	11					
2-1/2	11	14	9	13					
3	12	15	10	14					
4	14	17	12	16					
5	16	19	13	18					
6	17	21	14	20					
8	19	24	16	23					
10	22	26	18	25					
12	23	30	19	28					
14	25	32							
16	27	35							
18	28	37							
20	30	39							
24	32	42							
30	33	44							

Minimum Rod Diameter for Single Rigid Rod Hangers		
	Steel, Ductile Iron and Cast Iron Pipe	Copper, Glass and Plastic Pipe
Nominal Pipe or Tubing Size	Nominal Rod Diameter (inches)	Nominal Rod Diameter (inches)
1/4 - 2	3/8	3/8
2-1/2 - 3	½	1/2
4 - 5	5/8	1/2
6	¾	5/8
8	¾	3/4
10 - 12	7/8	3/4
14 - 18	1	
20 - 24	1-1/4	

Maximum Horizontal Pipe Hanger, Support, and Shield Spacing With MSS Type 40 Shields (ft)			
Standard Weight Steel Pipe			
Nominal Pipe Size	Shield Length (inches)	Shield Thickness (gage)	Hanger and Support Spacing (feet)
1/2 - 1-1/4	12	18	7
1-1/2	12	18	9
2 - 3	12	18	10
4	12	16	10
5 - 6	18	16	10
8 - 14	24	14	10
16 - 24	24	12	10
Copper Tubing			
Nominal Pipe Size	Shield Length (inches)	Shield Thickness (gage)	Hanger and Support Spacing (feet)
1/4 – 3/4	12	18	5
1	12	18	6
1-1/4	12	18	7
1-1/2 - 2	12	18	8
2-1/2	12	18	9
3	12	18	10
4	12	16	10
5 - 6	18	16	10
8	24	14	10

3.2 DUCT HANGERS

A. Duct hanging system shall be at contractor's option. Comply with SMACNA - HVAC Duct Construction Standards, Metal and Flexible and meet with approval of Engineer.

B. Vertical Ducts Through Floor Slabs: Are to be supported on two sides by galvanized steel angles bolted to duct and resting on floor slab. Supporting angles are to be bolted to floor, ceiling or wall to prevent vibration.

C. Vertical Ducts In Open Shafts: Provide additional galvanized structural steel members to span openings for support of ducts and angles at each floor.

D. Ducts Along Walls: Are to have supports spaced not more than 8 feet apart.

E. Provide hangers at the center of every ell or change in direction of horizontal ductwork.

F. Wire strap or perforated hangers will not be permitted.

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 bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports. Ensure that lateral motion under equipment at start-up, shut-down or when unbalanced is no more than 1/4 inch.

D. Provide templates, anchor bolts and accessories for mounting and anchoring equipment.

E. Provide rigid anchors for pipes after vibration isolation components are installed.

F. Provide corrosion resistant mounting systems when exposed to the elements and other corrosive environments.

3.4 UPPER ATTACHMENTS

A. Provide inserts for placement in formwork before concrete is poured.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4".

D. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.5 ROOF SUPPORTS

A. Verify that roofing system is complete and roof surfaces are smooth, flat, and ready to receive work of this section.

B. Clean surfaces of roof in areas to received supports.

C. Install in accordance with manufacturer's instructions. Provide flexible sheet flash and counterflash with sheet metal and caulk as necessary to make installation water tight. Weld, bolt, or screw roof curbs as instructed by manufacturer.

D. Equipment Supports

1. Locate bases and support framing as required by equipment manufacturer. Provide complete and adequate support of equipment whether or not all required devices are shown.

E. Pipe and Duct Supports

1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping and ducts whether or not all required devices are shown.
2. The use of wood for supporting piping is not permitted.
3. Provide supports spaced so deflection of piping does not exceed L/240 of span.
4. Install framing at spacing indicated, but in no case at greater than 10 feet (3 m) on center.

3.6 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/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.

3.7 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 1½".

C. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

3.8 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

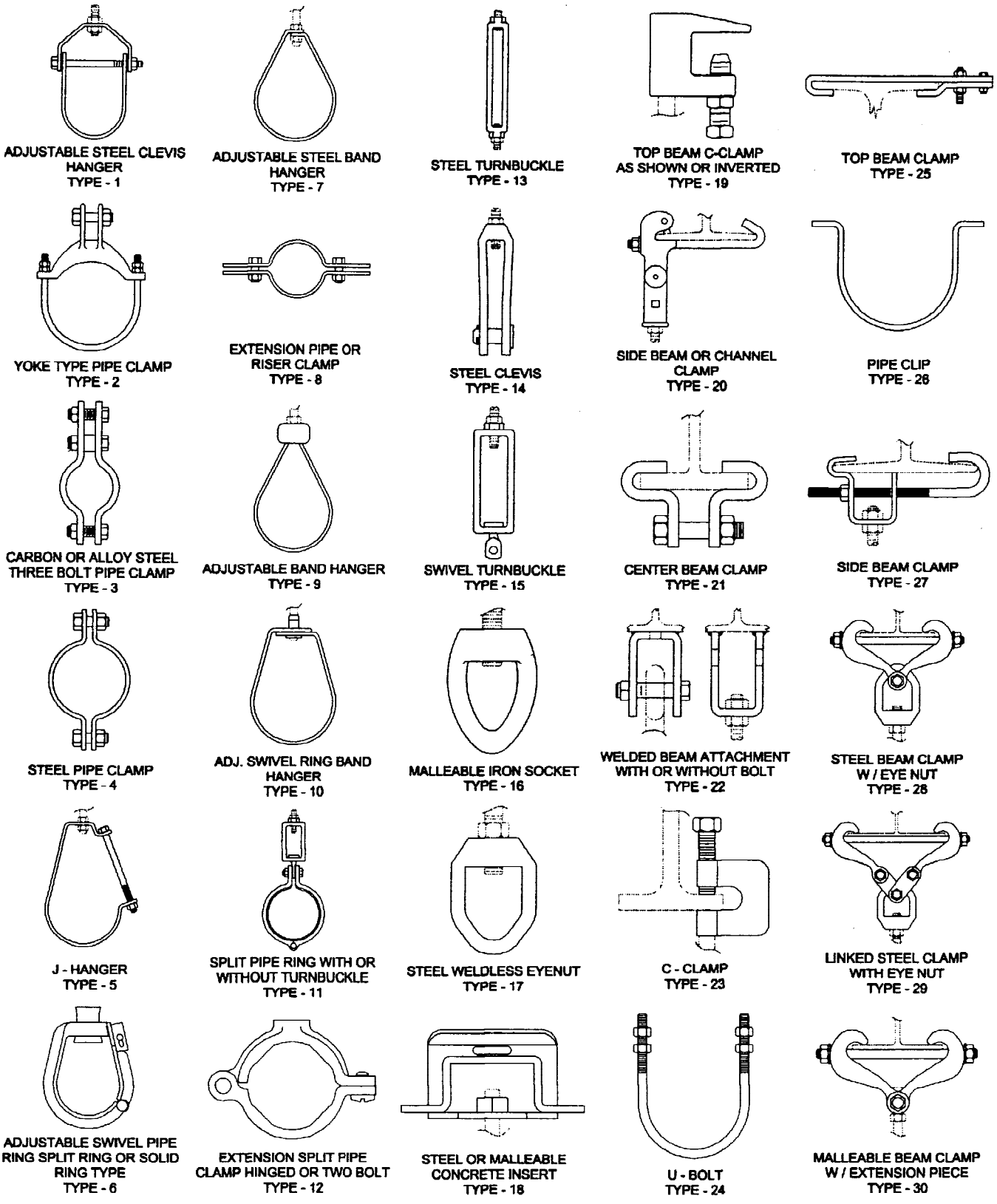
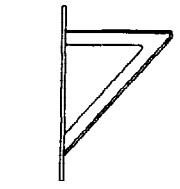
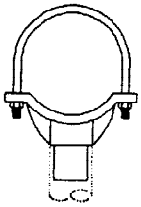


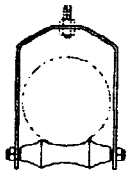
FIGURE 1. TYPE CHART



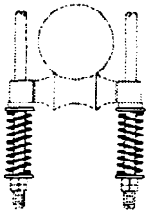
LIGHT WELDED STEEL BRACKET TYPE - 31



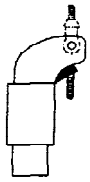
PIPE STANCHION SADDLE TYPE - 37



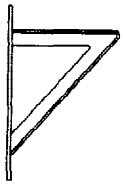
ADJUSTABLE ROLLER HANGER WITH OR WITHOUT SWIVEL TYPE - 43



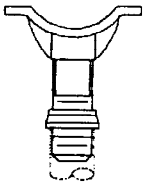
SPRING CUSHION ROLL TYPE - 49



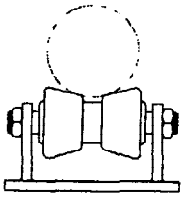
VERTICAL CONSTANT SUPPORT HANGER TYPE - 55



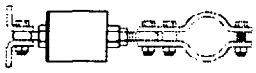
MEDIUM WELDED STEEL BRACKET TYPE - 32



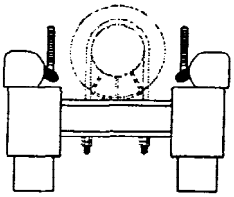
ADJUSTABLE PIPE SADDLE SUPPORT TYPE - 38



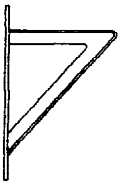
PIPE ROLL COMPLETE TYPE - 44



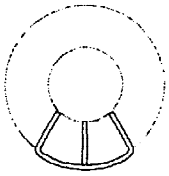
SPRING SWAY BRACE TYPE - 50



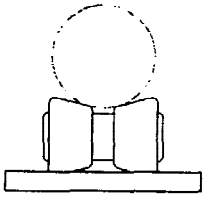
TRAPEZE CONSTANT SUPPORT HANGER TYPE - 56



HEAVY WELDED STEEL BRACKET TYPE - 33



STEEL PIPE COVERING PROTECTIVE SADDLE TYPE - 39



PIPE ROLL AND PLATE TYPE - 45

VARIABLE SPRING HANGER TYPE - 51

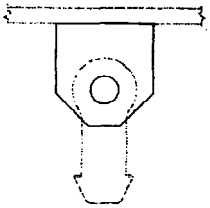
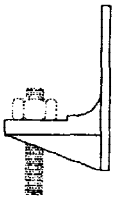
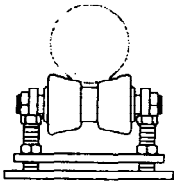


PLATE LUG TYPE - 57

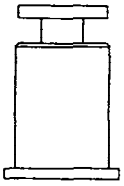


SIDE BEAM BRACKET TYPE - 34

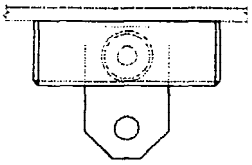
PROTECTION SHIELD TYPE - 40



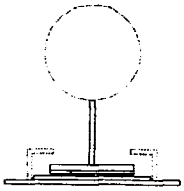
ADJUSTABLE PIPE ROLL AND BASE TYPE - 46



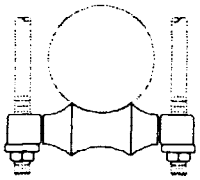
VARIABLE SPRING BASE SUPPORT TYPE - 52



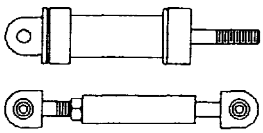
HORIZONTAL TRAVELER TYPE - 58



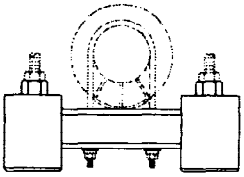
PIPE SLIDE & SLIDE PLATE TYPE - 35



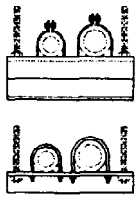
SINGLE PIPE ROLL TYPE - 41



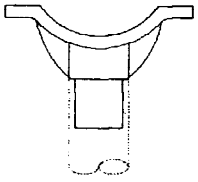
RESTRAINT CONTROL DEVICE TYPE - 47



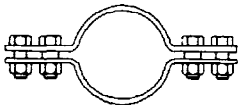
VARIABLE SPRING TRAPEZE HANGER TYPE - 53



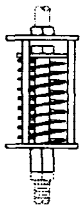
TRAPEZE HANGER TYPE - 59



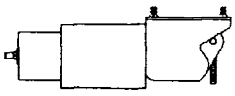
PIPE SADDLE SUPPORT TYPE - 36



CARBON OR ALLOY STEEL RISER CLAMP TYPE - 42



SPRING CUSHION TYPE - 48



HORIZONTAL CONSTANT SUPPORT HANGER TYPE - 54

FIGURE 1. TYPE CHART

SECTION 20 0548
VIBRATION ISOLATION FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Vibration isolation devices specifically applicable to Divisions 20, 21, 22, and 23, including:

1. Vibration Isolators
    a. Neoprene Pads (Type VI-1)
    b. Neoprene Mounts (Type VI-2)
    c. Free standing spring isolators (Type VI-3)
    d. Restrained spring isolators (Type VI-4)
    e. Spring hangers (Type H-3)
    f. Pre-compressed spring hangers (Type H-4)
2. Restrained Vibration Isolation Roof-Curb (Type Curb-D)
3. Flexible Pipe Connectors
    a. Rubber flexible connectors
    b. Stainless steel hose flexible connectors
    c. Bronze hose flexible connectors
4. Vertical Pipe Riser Supports
    a. Resilient pipe riser supports
    b. Resilient pipe riser guides
5. Horizontal Thrust Restraints

1.2 DEFINITIONS

A. ICC-ES: ICC-Evaluation Service.

B. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California

1.3 CODES AND STANDARDS (USE LATEST EDITIONS)

A. American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)
    1. ASHRAE 2007 Applications Handbook Chapter 47, Sound and Vibration Control

B. International Building Codes
    1. International Building Code (IBC)

C. Manufacturers Standardization Society (MSS)
    1. MSS SP-58-02: Pipe Hangers and Support Materials, Design and Manufacture

D. Occupational Safety and Health Administration (OSHA)
    1. 29CFR 1910.95 – Occupational Noise Exposure

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."

1.5 SUBMITTALS

A. To be provided to the Vibration Isolation Manufacturer's Representative:

1. A complete set of shop drawings for all equipment to receive vibration isolation from which the Vibration Isolation Manufacturer's Representative shall base the selection of vibration isolators and design of supplementary bases. The drawings shall include locations of all mechanical equipment to receive vibration isolation devices, operating weight of the equipment to be isolated and the distribution of weight to the support points.

B. Submit the following to the Engineer:

1. Product Data: For each vibration isolation device, provide the following:

a. Manufacturer name
b. Isolator type and model number
c. Material and construction of finish
d. Dimensional data
e. Rated load, rated deflection, and overload capacity
f. For spring vibration isolation devices include:

(1) Spring diameters
(2) Static deflection
(3) Free height
(4) Compressed spring height and solid spring height

g. Drawings or schedule indicating which isolators are to be used on which equipment at a particular locations

2. For flexible pipe connectors provide the following:

a. Maximum allowable temperature and pressure rating
b. Overall face-to-face length
c. Live length
d. Hose wall thickness
e. Hose convolutions per foot and per assembly
f. Fundamental frequency of assembly
g. Braid structure and total number of wires in braid (for stainless steel only)

3. Provide a complete layout of piping to be isolated, including vertical risers, showing size or weight and support points of the piping system to the vibration isolation materials manufacturer for selection and layout of isolation hangers.
4. Welding certificates, if applicable.
5. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Acceptable Manufacturers

1. Kinetics Noise Control
2. Mason Industries
3. Vibro Acoustics

B. General requirements applicable to all isolators:

1. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
2. Minimum Additional Travel Distance to Solid: 50% of the required deflection at rated load.
3. Lateral Stiffness: More than 80% of rated vertical stiffness.
4. Overload Capacity: Support 200 % of rated load, fully compressed, without deformation or failure.
5. Operating static deflection: Refer to the Applications table in Part 3.
6. Materials:
   a. Indoor: Housings and springs shall be powder coated steel and hardware shall be electro-galvanized.
   b. Outdoor: Hot dip galvanized housings and cadmium plated spring elements in compliance with ASTM A123.
7. Springs shall be color coded to indicate load capacity.

C. Neoprene Pads **(Type VI-1)**

1. Two layers of ¾" thick neoprene pad of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates; factory cut to sizes that match requirements of supported equipment.
2. Basis of Design: Mason Industries Type Super "W"

D. Neoprene Mounts **(Type VI-2)**

1. Double-deflection neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. All metal surfaces shall be neoprene covered and have friction pads both top and bottom.
2. Basis of Design: Mason Industries Type ND

E. Free Standing Spring Isolators **(Type VI-3)**

1. Free standing, laterally stable open (without any housing)
2. Baseplates: Bonded to ¼" thick, neoprene acoustical friction pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
   a. Baseplates shall be provided with bolt holes for any equipment which is to be mounted on framing or structural steel. Bolt holes are not required for equipment being mounted directly on the slab or on a concrete pad.
3. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment. Adjustment bolts shall be rigidly bolted to the equipment. Installed and operating heights shall be equal.

4. Basis of Design: Mason Industries Type SLF (without bolt holes) or SLFH (with baseplate bolt holes)

F. Restrained Spring Isolators **(Type VI-4)**

1. Freestanding, steel, open-spring isolators with limit-stop restraint
2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; baseplate with factory drilled bolt holes for bolting to mounting surface, bonded to 1/4" thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Vertical limit stops shall be out of contact during normal operation. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 1/2" to avoid bumping and interfering with the spring action.
3. For equipment located outside, limit stops shall resist wind velocity up to 130 mph.
4. Restraint: Limit stop as required for equipment. Restraining bolts shall have rubber grommets to provide cushioning in the vertical as well as horizontal directions. The hole through the bushing shall be a minimum of 3/4" larger in diameter than the restraining bolt.
5. Basis of Design: Mason Industries Type SLR

G. Spring Hangers **(Type H-3)**

1. Hangers shall consist of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top and a steel spring seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability, the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc from side to side before contacting the cup bushing and short circuiting the spring.
    a. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
    b. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
2. Basis of Design: Mason Industries Type 30N

H. Pre-Compressed Spring Hangers **(Type H-4)**

1. Hanger specification shall be the same as Type F Spring Hangers, but they shall be pre-compressed and locked at the rated deflection by means of a resilient up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale.
2. Basis of Design: Mason Industries Type PC30N

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB (TYPE CURB-D)

A. Acceptable manufacturers

1. Thybar Corporation

B. Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment to withstand wind forces.

1. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 "of rigid, glass-fiber insulation on inside of assembly.
2. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on ¼" thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
    a. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with wind restraint.
        (1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
        (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 rated vertical stiffness.
        (5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
        (6) Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
            (a) Resilient Material: Oil- and water-resistant standard neoprene.
3. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.
4. Basis of Design: Thybar Vibro-Curb II.

2.3 EPDM FLEXIBLE PIPE CONNECTORS

A. Acceptable Manufacturers

1. Mason Industries

B. EPDM Flexible Pipe Connectors

1. Spherical pipe connectors shall consist of EPDM body and liner and bias-ply tire core reinforcing. The connector shall be of double sphere design with middle ring and shall allow for compression, elongation and angular movement complete with stabilizing ring and control rods.
2. Minimum compression shall be 1-1/4" for sizes up to 6" and 1-1/2" for larger sizes.

3. Rated for a minimum operating pressure and temperature of 250 psi up to 170°F and 215 psi at 250°F.
4. The connector shall be furnished with steel cables which act as control units.
5. Basis of Design: Mason Industries Safeflex

2.4 STAINLESS STEEL AND BRONZE HOSE FLEXIBLE PIPE CONNECTORS

A. Acceptable Manufacturers

1. Mason Industries
2. Metraflex

B. Stainless Steel Hose Flexible Pipe Connectors

1. Flexible hose shall be 321 stainless steel close pitch annular corrugated hose with a braided 304 stainless steel outer covering.
2. For potable water service, connectors shall be UL classified in accordance with ANSI/NSF 61-1977 standards.
3. For pipe diameters up to 2-1/2″:
   a. End connections shall be male carbon steel nipples with NPT threads carbon steel and shall be the minimum lengths as defined below.
   b. Rated for a minimum operating pressure of 345 psi at up to 70°F.
   c. The overall length shall allow for a minimum of 1/2″ static offset, 1/4″ intermittent flexing, or per manufacturer's recommendations for additional motion.

Pipe Diameter (inches)	Overall Length (inches)
1/2	9
3/4	10
1	11
1-1/4	12
1-1/2	13
2	14
2-1/2	18

   d. Basis of Design: Metraflex Model SST
4. For pipe diameters 3″ and larger:
   a. End connections to be ANSI class 150 carbon steel plate flanges and shall be the minimum lengths as defined below.
   b. Rated for a minimum operating pressure of 125 psi at up to 70°F.
   c. The overall length shall allow for 3/4″ static offset and 3/8″ intermittent flexing offset or, per manufacturer's recommendations, for additional motion.

Pipe Diameter (inches)	Flange-to-Flange Length (inches)
3	14
4	19

Pipe Diameter (inches)	Flange-to-Flange Length (inches)
5	20
6	20
8	22
10	26
12	28
14	30
16	32

d. Basis of Design: Metraflex Model SLP

C. Bronze Hose Flexible Connectors

1. For pipe up to 2″:

a. Connectors shall be constructed of bronze hose and braided outer covering. End connections shall be female copper tube designed for braze connections.
b. Connectors shall be cleaned, de-greased, and bagged to protect from contamination.
c. Connectors shall be tested and approved by Underwriters Laboratories for refrigeration service.
d. Rated for a minimum operating pressure of 170 psi at up to 70°F.
e. Length shall be per manufacturer's recommendations.
f. Basis of Design: Metraflex Model BBT

2.5 VERTICAL PIPE RISER SUPPORTS

A. Acceptable Manufacturers

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Isolation

B. Pipe Riser Resilient Support

1. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2″ thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
2. Basis of Design: Mason Industries Type ADA.

C. Resilient Pipe Guides for Vertical Pipe Risers

1. Telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2″ thickness of neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin

shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2. Basis of Design: Mason Industries Type VSG.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Contractor shall consult with the local representative of the vibration isolation materials manufacturer, prior to installing any devices, in order to obtain guidance for this project's specific installation requirements.

3.2 APPLICATION

A. Provide vibration isolation devices for equipment per the following schedule.

1. The base type defined below indicates that bases independent of the equipment are required; the base type is not intended to define an equipment-specific factory base. Where "none" is indicated, the equipment and its integral factory-provided base shall be mounted directly on the defined isolators.

Isolated Equipment			Slab-on-Grade or Basement			Upper Floors (Spans up to 30 ft)			Comment
Type	HP or size	RPM	Base Type	Vibration Isolator		Base Type	Vibration Isolator		
				Type	Min Defl. Rating		Type	Min Defl. Rating	
Energy Recovery Units without Compressors	All	All	None	VI-1	0.25	Curb-D	VI-3	0.75″	
Package Direct Expansion Rooftop Unit	All	All	None	VI-1	0.25	Curb-D	VI-3	0.75″	
Ducted Rotating Equipment (fan powered boxes – inline fans)	All	All	None	VI-3	1″	None	VI-3	1″	

B. Provide vibration isolation for pipe connected to any isolated equipment per the following table:

Pipe Diameter	Location Requiring Isolated Hangers (distance from either side of isolated equipment)	Suspended Pipe Hanger Type	Floor-Mounted Pipe Isolator Type	Minimum Static Deflection
Up to 4"	First 3 points of support on either side of isolated equipment	H-3	VI-3	First point: twice deflection of isolated equipment Remaining 2 points: 0.75"

3.3 INSTALLATION

A. General vibration isolation requirements:

1. The Vibration Isolator Manufacturer or the Manufacturer's Representative shall:
   a. Supply isolator and other related equipment including rails, resilient pipe supports, fan and motor bases and structural steel forms for concrete inertia blocks wherever required.
   b. Be responsible for proper isolator sizing to accomplish the uniform static deflection according to distribution of weight based on factory certified manufacturer's drawings of equipment to be isolated.
   c. Select springs to operate at 2/3 maximum compression or provide alternate recommendation.
2. Refer to Applications Table for base type, isolator type and required deflection for each type of equipment.
3. All motor driven mechanical equipment shall be isolated from the building structure by means of vibration isolators. If specific equipment type is not listed in the Application Table, the Contractor shall notify Engineer in writing and obtain specification from Engineer or provide vibration isolation per 2003 ASHRAE Handbook HVAC Applications Table 42.
4. No rigid connections between isolated equipments and building structure shall be made that degrades the vibration isolations systems; electrical conduit connections to isolated equipment shall be looped to allow free motion of isolated equipment. Coordinate with Electrical Contractor.

B. Requirements for vibration isolation of equipment with spring type vibration isolators:

1. Vibration isolators shall be of such design so that the limit stops are out of contact during normal operation. Should the isolator mounts be "driven solid" leaving no gap for normal isolator operation, the Contractor shall correct the installation by adding vibration isolation hangers to support connected pipe and/or duct or replacing the vibration isolator with a properly selected isolator.
2. For restrained spring isolators with vertical limit stops (to prevent spring extension when weight is removed), provide temporary steel spacers between the upper and lower housings. Housings shall serve as blocking during erection. When the equipment is at full operating weight, the springs shall be adjusted to assume the weight and the spacers removed without changing the installed and operating heights.
3. All equipment shall be adjusted level.

C. Requirements for flexible pipe connectors:

1. Install flexible pipe connectors on pipes connected to all rotating or reciprocating equipment and equipment supported by vibration isolation.
2. Provide flexible connectors suitable for pressure, temperature and fluid involved.
3. Pump flexible connection shall be sized based on pipe size and not the pump inlet or outlet size.
4. Equipment flexible connectors shall be located between shutoff valves and the equipment.
5. Flexible connectors shall not be used as compensators for piping misalignment. Pipe connections shall be properly center-to-center aligned.

D. Requirements for Horizontal Piping Vibration Isolation

1. Provide spring isolators on piping connected to equipment with vibration isolators per the Application Table above.
2. Heat exchangers, air separators and other non-rotating equipment located in piping runs, shall be considered part of the piping system and isolated according to the requirements of the piping to which it is connected. Thus, if the associated piping adjacent to the suspended equipment requires vibration isolation, the equipment shall be isolated with the same vibration isolators used to support the pipe.
3. Hangers shall be located as close to the overhead support steel or structural slab as practical.
4. Piping shall pass through walls and floors without rigid connections to building structures. Penetration points shall be sleeved or otherwise formed to allow passage of piping and maintain spacing required by the UL listed wall fire suppression penetration assembly.

E. Requirements for Vertical Piping Riser Supports

1. For all vertical risers, Contractor to provide a fully engineered riser/support isolation system to minimize deflections into the building structure. The Vibration Isolation Equipment Manufacturer Representative shall design and provide required brackets or clamps at riser spring guide and anchor locations. The Contractor to install and adjust isolators under supervision of the isolation equipment manufacturer's representative.
2. Vertical pipe risers shall be designed to support the riser piping filled with fluid. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors close to the center of the run shall direct movement up and down.
3. The anchors shall be capable of holding an upward force equal to the fluid weight when the system is drained. If one level cannot accommodate this force, anchors shall be located on 2 or 3 adjacent floors. Resilient guides shall be spaced and sized in accordance with the pipe diameter and insulation thickness.
4. Vertical Pipe Risers shall be supported using Vertical Pipe Riser Resilient Supports and Resilient Pipe Guides for Vertical Pipe Risers.

F. Requirements for ductwork isolation

1. Ductwork with working static pressures of 4" or greater and connected to isolated equipment shall be isolated with spring isolator type VI-4 (suspended)

of H-4 (floor mounted) within the confines of the mechanical equipment room or within 50 ft proximity to mechanical equipment, whichever is greater.

G. On completion of installation of all isolation materials and before start-up of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.

3.4 INSPECTION

A. On completion of installation of all noise and vibration isolation devices, the local Manufacturer's Representative shall inspect the completed system and furnish the report to Architect/Engineer indicating installation errors or other faults in the system that affect the isolating system performance. The report shall indicate whether the isolation equipment has been properly installed or, if it requires correcting, the steps needed to properly complete the work. The final report shall certify that the deficiency listed have been corrected, the equipment has been properly installed and functional.

END OF SECTION

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SECTION 20 0553
IDENTIFICATION FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Identification of mechanical products installed under Divisions 20, 21, 22, and 23 as defined below:

1. Pipe labels
2. Duct labels
3. Equipment labels
4. Valve tags
5. Labels for miscellaneous electrical for temperature controls

1.2 DEFINITIONS

A. AHU: Air handling unit

B. DI: Deionized

C. OD: Outer diameter based on pipe outside diameter; for the purpose of this specification section, the outer diameter of pipe with insulation includes the insulation.

D. RO: Reverse osmosis

E. TC: Temperature controls

1.3 CODES AND STANDARDS (USE LATEST EDITION)

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

1. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.

B. International Codes

1. International Mechanical Code (IMC)

C. Underwriters Laboratory (UL)

1. UL E-84-03: Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 QUALITY ASSURANCE

A. For hydronic piping, conform to ANSI/ASME A13.1 requirements for color, length of color field and letter height.

B. Label fire dampers, smoke dampers and combination fire/smoke dampers per IMC.

C. Stencils shall not be used.

D. Labels/markers listed by the manufacturer as “economy” or “value” shall not be used.

1.5 SUBMITTALS

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

1. Manufacturer’s data including colors, materials, wording, symbols, letter size, methods of attachment and color coding for mechanical and electrical identification of piping, ductwork and equipment.
2. Submit manufacturer’s installation instructions.

B. Valve Schedule:

1. Submit proposed valve chart and schedule for approval prior to installing valve tags. Include valve tag number, location, function and valve manufacturer's name and model number.
2. Provide "as-installed" valve tag schedule for Owner at completion of project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Brimar Identification and Safety Products

B. Kolbi Pipe Marker Co.

C. Marking Services Inc. (MSI)

D. Seton Identification and Safety

2.2 PIPE LABELS

A. General Requirements for All Pipe Labels:

1. Preprinted, color-coded, with lettering indicating service, and showing flow direction
2. Pipe Label Contents:
   (1) Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and arrows indicating flow direction.
   (2) Flow-Direction Arrows: Integral with piping system service lettering or as separate unit on each pipe label to indicate flow direction.
3. Minimum marker width and lettering height shall be per the following table:

Pipe OD	Minimum Marker Width	Minimum Letter Height
Up to 1"	8"	1/2"
1-1/8" through 2¼"	8"	3/4"
2-3/8" through 7-7/8"	12"	1¼"
8" through 10"	24"	2½"
Larger than 10"	32"	3½"

B. Normal Service Coiled Pipe Labels

1. Precoiled, semi-rigid plastic formed with a service temperature range of -40°F to 160°F. Label shall be formed to partially or fully cover the circumference of pipe and to attach to pipe without adhesive.
   a. Where required by pipe OD, provide galvanized straps for indoor applications and stainless steel straps for outdoor application for securing coiled pipe labels.
2. Basis of Design: MSI MS-970

C. Self-Adhesive Pipe Labels

1. Printed plastic with contact-type, permanent-adhesive backing used in association with flow directional arrow tape which wraps fully around the pipe.

2. Basis of Design: MS-900 with MS-900 Flow Directional Arrow Tape

D. Small Diameter Pipe Labels

1. Construction:

a. 3″ x 3″ labels with ¼″ high lettering designed to completely wrap around pipe.

b. Label shall show content and have integral flow indicating arrow.

2. Basis of Design: MS-900 TM Markers for Tubing & Small Pipe

2.3 DUCT LABELS

A. General Requirements for All Duct Labels:

1. Comply with ANSI/ASME A13.1 requirements for color, length of color field and letter height.

2. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

B. Standard Duct Labels

1. Multilayer, multicolor, plastic labels for mechanical engraving and having predrilled holes for attachment hardware. Able to withstand temperatures up to 160 F. Minimum plastic label thickness shall be as follows:

a. 1/16″ for labels up to 2″ x 6″

b. 1/8″ for labels longer than 6″ or taller than 2″

2. Label Size:

a. For ductwork and plenums up to 12″ in height, duct markers shall be a minimum of 2¼″ x 13″.

b. For ductwork and plenums larger than 12″ in height, duct markers shall be 4″ x 24″.

3. Lettering Size:

a. A minimum letter size of 1/2″ high lettering for labels that are normally viewed from distances up to 6′.

b. If label must be viewed from greater than a 6′ distance (e.g. duct is at a high elevation and must be viewed from the floor), the minimum text size is 1½″.

c. Secondary lettering shall be two-thirds to three-fourths the size of principal lettering.

4. Contact-type permanent adhesive, compatible with label and with substrate shall be utilized.

5. Basis of Design: MSI Engraved Plastic Signs

2.4 EQUIPMENT LABELS

A. General Requirements for Equipment Labels

1. Label Content: Include equipment's Drawing designation or unique equipment number.

2. Equipment Label Schedule: For each item of equipment to be labeled provide am equipment label schedule on 8½″ x 11″ bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is

indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

3. Label Size: Length and width may vary for required label content shall not be less than 2″ x 4″.
4. Lettering Size: A minimum letter size of 1½″ high. If label must be viewed from greater than 72″ away, the minimum text size is 1½″. Secondary lettering shall be two-thirds to three-fourths the size of principal lettering.

B. Indoor Equipment Labels

1. Multilayer, multicolor, 3-ply plastic labels for mechanical engraving and having predrilled holes for attachment hardware. Able to withstand temperatures up to 160°F. Minimum plastic label thickness shall be as follows:
   a. 1/16″ for labels up to and including either a maximum area of 18 square inches or 6″ in lengths.
   b. 1/8″ for labels larger than either 18 square inches in area or 6″ in length.
2. Contact-type permanent adhesive, compatible with label and with substrate shall be utilized.
3. Basis of Design MSI Engraved Plastic Equipment Tags & Signs

C. Outdoor Equipment Labels

1. Label shall be constructed of printed legends sealed between two layers of chemically resistant plastic and should be designed for outdoor duty and exposure to sun light. Labels shall have predrilled holes with stainless steel grommets for attachment hardware.
2. Service Temperature Range of -40°F to 200°F
3. Fasteners: Self tapping stainless-steel screws.
   a. Adhesive backing is acceptable only where screws cannot or should not penetrate the surface to which is attached. Contact-type permanent adhesive, compatible with label and with substrate shall be utilized.
4. Basis of Design: MS-995 MAXI-TEK Tags & Signs

2.5 VALVE TAGS

A. 2″ diameter or 2″ square 19 gauge valve tags each marked with ¼″ abbreviated service indicator on the top line and ½″ numbers below (example: HTG/309).

1. Tag Material: Minimum 19 gauge (0.032″) brass with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass S-hook.

2.6 LABELS FOR MISCELLANEOUS ELECTRICAL FOR TEMPERATURE CONTROLS

A. Self-Adhesive Pipe Labels

1. Printed plastic with contact-type, permanent-adhesive backing
2. Black text on orange labels

3. Basis of Design: MS-900 Conduit and Electrical ID

PART 3 - EXECUTION

3.1 APPLICATION

A. Piping label types shall be as follows:

Application	Label Type
Hydronic , plumbing and fire suppression pipe less than 6" OD located indoors, except steam or condensate pipe (e.g. chilled water, condenser water, heating hot water, domestic hot water recirculation, domestic cold water , domestic hot water)	Normal service coiled pipe labels with coil-on fastening
Pipe less than 6" OD that is located outdoors or in an underground vault (manhole)	Harsh service coiled pipe labels with coil-on fastening
Pipe 6" OD and larger that is located outdoors or in an underground vault (manhole)	Harsh service coiled pipe labels with strap-on fastening

B. Pipe label colors shall be as defined below; where a pipe fluid is not shown provide colors per ASME A13:

Pipe Fluid	Background Color	Lettering Color
Cold water systems including but not limited to chilled, condenser, domestic cold and RO water.	Green	White

C. Duct label colors shall be as follows:

Duct Air Type	Background Color	Lettering Color
Supply air	Blue	White
Outside, return and relief air	Green	White
Exhaust air (all types)	Yellow	Black

3.2 INSTALLATION

A. General Installation Requirements

1. 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.
2. Install marking in accordance with manufacturer's installation instructions.
3. Install identification prior to installation of acoustic ceiling and similar removable concealment.
4. Provide custom pipe and duct labels when standard labels meeting the requirements of this specification are not available.

B. Additional Requirements for Pipe Labels

1. Install pipe labels on all Divisions 20, 21, 22, and 23 pipe shown on drawings including [plumbing], [fire suppression] and [medical gas] pipe. Contractor shall coordinate between piping, plumbing and medical or lab gases so that each pipe

system is labeled with a distinct name. Labeled pipes include but are not necessarily limited to chilled water supply, chilled water return, condenser water supply, condenser water return, heating hot water supply, heating hot water return, domestic cold water, domestic hot water, domestic hot water recirculation, tempered water, medical air, medical vacuum, oxygen, lab air, lab vacuum, sprinkler, fire main, acid waste and acid vent.

2. Labels shall indicate pipe content as shown on drawings (e.g. REHEAT HOT WATER SUPPLY, CHILLED WATER SUPPLY) and direction of fluid flow. For steam and condensate less than 100 lb operating pressure, indicate "LOW PRESSURE STEAM" or "MEDIUM PRESSURE STEAM" as indicated on drawings. For steam and condensate operating at 100 lbs or greater, labels shall indicate the system working pressure (e.g.130 LB STEAM).
3. Install pipe labels after application of insulation and/or final painting.
4. Label all piping, both exposed and concealed, including piping located in accessible maintenance spaces such as shafts, tunnels, and plenums. Locate labels as follows:
    a. Near each valve and control device.
    b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
    c. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
    d. At access doors, manholes, and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.
    f. Space at maximum intervals of 25 feet along each straight portion of pipe. Each straight run must have an individual label regardless of its length.
5. Install in clear view and align with axis of piping.
6. Where self-adhesive pipe labels are allowed, wrap each end of the pipe labels with directional tape. Directional tape shall be wrapped circumferentially completely around pipe at both ends of the pipe marking label. Arrow tape color shall match marker color.
    a. Tape shall be 1" wide on piping up to and including 10" OD and 2" wide on piping larger than 10" OD.

C. Additional Requirements for Duct Labels

1. Duct labels shall indicate the air handling equipment serving the duct and the area served (e.g. "AHU-7 3RD FLOOR SUPPLY AIR, EF-3 KITCHEN EXHAUST", etc.).
2. Label ductwork at the following locations:
    a. In each space where ducts are exposed or concealed by removable ceiling system at maximum intervals of 50 feet
    b. Entering and leaving an air handling unit
    c. Entering and leaving any supply, return or exhaust fan
    d. At each side of a penetration of structure or enclosure

3. At each duct access door located in ductwork or housings, provide label indicating purpose of access (to what equipment) and other maintenance and operating instructions and appropriate safety and procedural information.
    a. Where access doors are concealed, such as above acoustical ceilings, provide secondary plasticized tags in visible locations if desired and acceptable to the Owner.

D. Additional Requirements for Equipment Labels

1. Provide labeling for all mechanical and plumbing equipment including but not limited to the equipment defined below. Equipment label text shall provide the name and number of the identified equipment, as well as the system or location which the equipment serves. Indicate when equipment is stand-by. Examples of the required text is given below:
    a. AHUs: (e.g. AHU-1, air handling unit serving 1st floor west)
    b. Fans: (e.g.TE-1, toilet exhaust for lobby toilets)
    c. Chillers: (CH-1 Chiller for main chiller plant)
    d. Boilers: (B-1, stand-by boiler for main boiler plant)
    e. Pumps: (P-1, heating hot water pump)
    f. Variable frequency drives: (VFD-1, VFD for AHU-1 supply fan)
    g. Heat exchangers: (HX-1 heat exchanger for reheat hot water loop)
    h. Tanks and pressure vessels
    i. Humidifiers
    j. Water treatment equipment
    k. Temperature control panels and other major control equipment
2. Confirm equipment numbering scheme with Owner; provide different numbering scheme than that shown on drawings if required by Owner. If Owner has no preference, number as shown on drawings.

E. Additional Requirements for Valves Tags

1. Customize tags in accordance with system. Coordinate the valve system numbering sequence with the Owner.
2. Install tags on all valves and control devices located in main and branch piping systems.
    a. Exceptions: Check valves, convenience and lawn-watering hose connections. List tagged valves in a valve schedule. Identify valves in main and branch piping with tags.
3. Secure tags to valves in visible position using brass jack or bead chain.
4. Provide valve chart and schedule at completion of project. Provide in aluminum frame with clear plastic shield, and install at Owner-directed location.

F. Additional Requirements for Labels for Miscellaneous Electrical for Temperature Controls

1. Identify temperature control conduit and electrical conduit installed as part of the temperature control work.

G. Additional Requirements for Underground Utility Warning Tape

1. Provide underground utility warning table for all piping buried underground.

2. Install the continuous warning tape above the buried pipe at approximately half the depth of burial.
3. Provide Plastic Underground Warning Tape for metallic pipes and Detectable Underground Warning Tape for non-metallic pipes.

END OF SECTION

SECTION 20 0700
THERMAL INSULATION FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Thermal insulation products specifically applicable to Divisions 20, 21, 22, and 23, including:

1. Insulation
2. Protective coverings
3. Accessories
4. Repairs to all existing insulation cut or damaged by work performed under this Contract.

B. Products furnished but not installed under this section: None.

C. Products installed but not furnished under this section: None.

D. Services provided:

1. Design - None.
2. Training - None.
3. Obtain permits - None.

1.2 DEFINITIONS

A. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.

B. Ductwork Insulation: Thermal insulation applied to prevent heat transmission to or from a duct system.

C. Equipment Insulation: Thermal insulation applied to prevent heat transmission to or from a piece of equipment that is part of a plumbing, heating or cooling system.

D. Jacket: Protective covering over insulation; may be factory applied such as "all service jacket" or field applied to provide additional protection; of such materials as canvas, polyvinyl chloride (PVC), aluminum or stainless steel.

E. Vapor Retarder Jacket: Insulation jacket material which impedes the transmission of water vapor.

F. Insert: Spacer placed between the equipment support system and the equipment to allow for the space required for insulation.

G. Insulation Shield: Buffer material placed between the equipment support system and the insulation to prevent the insulation material from crushing.

1.3 CODES AND STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate).

3. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
8. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation.
9. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
10. ASTM C553 - Mineral Fiber Blanket and Felt Insulation (Industrial Type).
11. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
12. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
13. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
14. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
15. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
16. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
17. Midwest Insulation Contractors Association (MICA) - Commercial and Industrial Insulation Standards.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE Standard 90.1-1989 Energy Efficient Design of New Buildings Except New Low-Rise Residential Buildings.

C. National Fire Protection Association (NFPA)

1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
2. NFPA-90A - Installation of Air Conditioning and Ventilation Systems.
3. NFPA-90B - Warm Air Heating and Air-Conditioning Systems.

D. National Insulation and Abatement Contractors Association (NIACA) - Guide to Insulation Product Specifications.

E. North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.

F. Underwriters Laboratory (UL)

1. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum five years documented experience.

C. Products: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84 or NFPA 255 or UL 723.

D. No insulation product shall support or promote mold or fungus growth.

1.5 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data: Provide a schedule, listing each type of insulation, thickness, density, type of protective covering, etc., and the work and service to which each type of insulation is to be applied. The schedule shall be submitted in quantities consistent with that required in the Conditions of the Contract. No insulation shall be purchased or installed until the schedule is reviewed by the Engineer.

C. Manufacturer's Installation Instructions: Indicate specific installation instructions per the manufacturers of the various products and indicate how the system (combination of products) will be assembled. Highlight critical environmental factors such as drying time, etc., as well as any variations between the manufacturer's installation instructions and the specified installation instructions along with a reason for the difference.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 01.

B. Deliver products to site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

C. Protect products against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged or wet insulation; remove from project site. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to Owner.

D. Where existing insulation has been removed or disturbed, due to new connections and/or alterations, repair and replace existing insulation using materials that match existing, except where existing insulation includes asbestos material.

E. Existing insulation containing asbestos materials (or thought to contain asbestos materials) must be removed by Owner, either totally or in part, in strict accordance with OSHA Regulations utilizing OSHA approved Contractors. Repair and/or replacement of existing insulation containing asbestos shall be with new products as specified herein.

F. Maintain ambient conditions required by the manufacturer of each product.

1.7 SPARE PARTS

A. Six rolls of tape to be used for sealing penetrations in vapor retarder jackets.

1.8 WARRANTY

A. One year warranty on products and complete installation commencing at the time of Substantial Completion.

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 INSULATION

A. Acceptable Manufacturers

1. Johns Manville
2. Owens-Corning
3. Knauf
4. Armstrong
5. Certainteed Corp.
6. Rock Wool Manufacturing

B. Type GFP: *Glass fiber pipe* insulation; ANSI/ASTM C547, rigid molded, for use to 850F; thermal conductivity ('k' value) of 0.23 (Btu)/(hr ft² EF) at 75°F mean temperature, k=0.29 at 200°F, k=0.43 at 400°F; noncombustible factory-applied white kraft paper bonded to aluminum foil and reinforced with glass fibers (ASJ) (vapor permeability shall not exceed .02 perms) that has a self-sealing longitudinal lap which provides positive closure without the use of tools, staples, adhesives, ties or tape at ambient temperatures between 25°F and 110°F shall be provided as a vapor retarder.

C. Type GFFB: *Glass fiber flexible blanket* insulation; ASTM C553; for use to 250°F; 'k' value of .28 at 75°F mean temperature; commercial grade; ¾ lb/cu ft minimum density; noncombustible factory-applied foil-scrim kraft (FSK) jacket (vapor permeability shall not exceed .02 perms). OR vinyl vapor retarder.

D. Type GFRB: *Glass fiber rigid board* insulation; ASTM C612; for use to 250°F; 'k' value of .28 at 75°F mean temperature Class 2; 3 lb/cu ft minimum density; noncombustible factory-applied foil-scrim kraft (FSK) jacket (vapor permeability shall not exceed .02 perms). OR all service jacket (ASJ).

E. Type MFP: *Mineral fiber pipe* insulation; ASTM C-612-83/ASTM E-136, Federal HH-1-558B; rigid molded; 10 lb/cu ft minimum density, surface temperature not to exceed 105°F; foil scrim kraft jacket (FSK). OR all service jacket (ASJ).

F. Type MFFB: *Mineral fiber flexible blanket* insulation; ASTM C-553/ASTM E-136, Federal HH-1-558B; 6 lb/cu ft minimum density, R-value/inch of 4.2, surface temperature not to exceed 105°F; foil scrim kraft jacket (FSK). OR all service jacket (ASJ).

G. Type MFRB: *Mineral fiber rigid board* insulation; ASTM C-612-83/ASTM E-136, Federal HH-I-558B, 6 lb/cu ft minimum density, surface temperature not to exceed 105°F; foil scrim kraft jacket (FSK). OR all service jacket (ASJ).

H. Type FEP: *Flexible elastomeric plastic* insulation; ANSI/ASTM C534; 'k' value of 0.27 at 75°F mean temperature.

2.2 PIPE PROTECTIVE COVERINGS

A. Acceptable Manufacturers

1. Childers (metal)
2. Knauf (metal)
3. Schuller International, Inc. (PVC)

4. Proto (PVC)

B. Interior Applications

1. Vapor Retarder Jackets: Integral to glass fiber insulation as specified above.
2. PVC Jackets: One piece pre-molded high impact PVC fitting covers with fiberglass inserts and accessories, to include elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, jacketing, tacks and PVC tape.
3. Glass Fabric and Mastic: Two coats mastic required with 10 x 10 glass fabric.

C. Exterior Applications

1. Aluminum Jackets: ASTM B209; 0.016" thick; stucco embossed.
2. Stainless Steel Jackets: Type 304 stainless steel; 0.010" thick; smooth finish.
3. PVC Jacket: One piece pre-molded high impact PVC fitting covers with fiberglass inserts and accessories, to include elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, jacketing, tacks and PVC tape.
4. Glass Fabric and Mastic: Two coats mastic required with 10 x 10 glass fabric.

2.3 PIPE ACCESSORIES

A. Acceptable Manufacturers

1. Foster
2. Minnesota Mining
3. Chicago Mastic

B. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool; compatible with the insulation and protective coverings.

C. Finishing Cement: ASTM C449; compatible with the insulation/fitting covers/jackets.

D. Adhesives and Tapes: Compatible with insulation and protective coverings.

E. Metal Jacket Bands: ½" wide; 0.016" thick aluminum.

2.4 DUCT/EQUIPMENT PROTECTIVE COVERINGS

A. Acceptable Manufacturers

1. Childers (metal)
2. Knauf (metal)
3. Schuller International, Inc. (PVC)

B. Indoor Jacket: Glass fabric mastic: Two coats mastic required with 10 x 10 glass fabric.

C. Outdoor Jacket

1. Aluminum ASTM B209, 0.016" thick, stucco embossed with seams located on bottom side.
2. Stainless Steel: Type 304 stainless steel; 0.010 thick; smooth finish.
3. Fiberglass Reinforced Plastic (FRP): Perma-Wrap manufactured by Filon.
4. Glass fabric and mastic: Two coats mastic required with 10 x 10 glass fabric.

2.5 DUCT/EQUIPMENT ACCESSORIES

A. Acceptable Manufacturers

1. Foster
2. Minnesota Mining
3. Chicago Mastic

B. Adhesives: Waterproof fire-retardant type.

C. Lagging Adhesive: Fire resistive to ASTM E84 or NFPA 255 or UL 723.

D. Joint Tape: Glass fiber cloth, open mesh.

E. Bedding Compounds: Non-shrinking, permanently flexible, compatible with insulation.

F. Vapor Retarder Coating: Non-flammable, fire resistant, polymeric resin, compatible with insulation.

G. Insulating Cement: ANSI/ASTM C195, hydraulic setting mineral wool.

H. Impale Anchors: Galvanized steel, 12 gauge, self-adhesive pad.

I. Tie Wire: Annealed steel, 16 gauge.

J. Wire Mesh: Corrosive-resistant metal; hexagonal pattern.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Install products only after piping, ductwork and equipment have been tested and approved.

B. Verify that surfaces are clean and dry with any and all foreign material removed.

C. Provide drop cloths or other means of protecting all equipment from drops, spattering, etc. which may be caused by the application of insulating products.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's and NAIMA instructions.

B. Whenever insulated pipes or ducts pass through sleeves or openings, the full specified thickness of the insulation shall pass through the sleeve or opening, except for sleeves located in fire rated partitions or floors. Space between pipe and sleeve located in fire rated partition or floor shall be sealed.

C. Contractor shall note that all adhesives shall be applied as specified, in continuous bands for complete coverage. The "spot" application of adhesives is not permitted.

D. Neatly finish insulation at supports, protrusions and interruptions.

E. Contractor shall coordinate with support and firestopping requirements as noted elsewhere in the Contract Documents.

3.3 APPLICATION (PIPING)

A. Schedule

INSULATION	OPERATING	
	TYPE	TEMP (°F)
Refrigerant (Hot Gas)	FEP	105
Refrigerant (Suction)	FEP	

B. Insulation thickness shall be as follows:

Fluid Design Operating Temperature Range, F	Nominal Pipe Diameter (in.)				
	< 1″	1″ to < 1½″	1½″ to < 4″	4″ to < 8″	8″ & up
Above 350°	4.5	5.0	5.0	5.0	5.0
251°-350°	3.0	4.0	4.5	4.5	4.5
201°-250°	2.5	2.5	2.5	3.0	3.0
100°-200°	1.5	1.5	2.0	2.0	2.0
40°-60°	1.5	1.5	1.5	1.5	1.5
Up to 39°	1.5	1.5	2.0	2.0	2.0

1. Use maximum fluid temperature for those systems where fluid temperature is above ambient temperature, minimum fluid temperature for those systems where fluid temperature is below ambient temperature.
2. EXCEPTION: Insulation thickness for roof drains and storm water shall be 1″.

C. Indoor, Concealed Pipe

1. End joints shall be sealed with minimum 3″ wide factory finished vapor retarder strips applied with adhesive.
2. All fittings, valves, strainers, etc. in piping 3″ and larger and all flanges in any size pipe shall be insulated with fabricated mitered or molded segments of fiberglass pipe insulation equal in thickness to the adjoining pipe insulation. Segments shall be firmly butted and securely wired in place with 16 gauge soft annealed copper clad wire wraps. Apply a ¼″ thick coat of insulation manufacturer's insulating cement over insulation and finish with a glass cloth jacket or a spiral wrap of stretchable glass tape between two coats of Foster No. 30-36 after cement is dry.
3. All fittings, valves, strainers, etc. in piping 2½″ and smaller shall be insulated with the insulation manufacturer's insulating cement applied in several layers to the equal thickness of adjoining pipe insulation and finished with a glass cloth jacket or a spiral wrap of stretchable glass tape between two coats of Foster No. 30-36.
4. Ends of pipe insulation shall be sealed off with fire resistive mastic, Foster 60-30, at all flanges, valves and fittings and at intervals of not more than 21 feet on continuous runs of pipe.
5. Insulation on all strainers shall have removable cover for cleaning.
6. Insulate all piping within air handling units.

D. Indoor, Exposed Pipe

1. For pipe exposed in mechanical equipment rooms or in finished spaces, insulate pipe, fittings, joints, and valves the same as for concealed applications.
2. Locate insulation and cover seams in least visible locations on exposed piping systems.

E. Where multiple layers of pipe insulation are required, all longitudinal and circumferential joints shall be staggered.

1. Product shall be installed in strict accordance with specifications provided by manufacturer.
2. Provide insulation for the following services:

a. High pressure steam supply
b. Condensate pump discharge
c. Chilled water (only where indicated)

3.4 APPLICATION (DUCTWORK)

A. Flexible ductwork insulation (Type GFFB) (1½" thick) shall be applied to all concealed (above ceiling, within shafts, etc.) supply ductwork.

1. Insulation shall be wrapped around and secured to ducts by means of the butt joint method of application along the duct length (longitudinal seam) and the butt joint method of application along the duct perimeter at the joints (longitudinal seam). Overlapping flap shall be at least 2" wide.
2. All edges of insulation shall be butted snugly together. Provide 4" wide tape on ducts at all joints, seams, edges, breaks, mechanical pin penetrations, etc.
3. Insulation shall be further secured to the bottom of horizontal ductwork or to all four sides of a vertical duct with approved type welded mechanical pins. These pins shall be applied on 12" centers to all surfaces of ductwork as follows:

Horizontal Duct Width	Vertical Duct Dimensions	Minimum Rows of Pins
Up to 11"	Up to 11"	No pins required
12" to 23"	12" to 23"	One
24" to 35"	24" to 35"	Two
36" to 47"	36" to 47"	Three
48" to 59"	48" to 59"	Four
60" to 71"	60" to 71"	Five
72" to 83"	72" to 83"	Six
84" to 95"	84" to 95"	Seven

4. Contractor shall install all insulation without sag.
5. All round ductwork shall be insulated same as specified above except no pins are required.

B. Rigid ductwork insulation (Type GFRB) (1½" thick) shall be applied to:

1. All outdoor air intakes, supply fan housings and supply plenums, from the point of entry into the building to the fan or supply AHU discharge.
2. Exhaust ducts from exhaust damper to outside.
3. All unconcealed supply ductwork within the building.
4. All exhaust/return, exhaust and recirculating air ductwork and housings within equipment rooms.
5. Insulation shall be secured to all four sides of ductwork with approved type welded mechanical pins. These pins shall be applied on 12" centers to all surfaces of ductwork as follows:

Duct Dimension	Minimum Rows of Pins
Up to 11"	No pins required
12" to 23"	One
24" to 35"	Two
36" to 47"	Three
48" to 59"	Four
60" to 71"	Five
72" to 83"	Six

Duct Dimension	Minimum Rows of Pins
84″ to 95″	Seven

6. Insulation shall be secured by applying Foster No. 85-20 adhesive in 4″ wide continuous bands on 12″ centers. Press/impale insulation into place, butting all edges together snugly.
7. Contractor shall install all insulation without sag.
8. After boards are impaled, the welded pins shall be cut to extend ⅛″ beyond face of board. A self-locking cap shall be pushed onto the pin after coating with Foster No. 30-35. All insulation edges, butt joints breaks and mechanical pin penetrations shall be sealed with joint sealing tape. Tape used to seal joints at exterior corners must be 5″ wide. Tape shall be pressure sealing type requiring no separate adhesive, installed in accordance with manufacturer's instructions.

C. All 100% exhaust system ductwork shall not be insulated.

D. Insulation at access panels shall be removable with metal corner beads.

E. The portions of plenums, casings or ductwork specified elsewhere to be internally lined for acoustical purposes shall not be externally insulated.

F. Insulate all supply and return ductwork which is exposed to the weather with rigid insulation as hereinbefore specified except thickness shall be 2″. Cover finished insulation with a 0.016″ thick aluminum jacket.

3.5 APPLICATION (EQUIPMENT)

A. Insulation shall be omitted at all equipment name plates and/or data plates.

B. Do not insulate factory insulated equipment.

C. Apply insulation as close as possible to equipment by grooving, scoring and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

D. Fill joints, cracks, seams and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

E. Insulate all duct-mounted hot water booster coils with insulation equivalent to that on the adjacent ductwork.

F. When equipment with insulation requires periodical opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.

3.6 ADJUSTING

Not Applicable

3.7 CLEANING

A. All empty cartons, containers, etc. which have contained insulating materials shall be removed from the site and premises by the Contractor as soon as possible after their contents have been removed.

END OF SECTION

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SECTION 23 0100
COMMON WORK REQUIREMENTS FOR MECHANICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic requirements applicable to all Division 23 work.

1.2 RELATED SECTIONS

A. All specification sections in Division 20 are applicable to Division 23. It is the responsibility of the Division 23 Contractor to obtain all Division 20 specifications and conform to all applicable requirements. Division 20 Sections included are:

1. Section 20 0500: Basic Requirements for Mechanical, Plumbing, and Fire Suppression
2. Section 20 0501: Minor Mechanical, Plumbing, and Fire Suppression Demolition
3. Section 20 0513: Motor Requirements for Mechanical, Plumbing, and Fire Suppression Equipment
4. Section 20 0529: Supports, Anchors, and Sleeves for Mechanical, Plumbing, and Fire Suppression
5. Section 20 0548: Vibration Isolation for Mechanical, Plumbing and Fire Suppression
6. Section 20 0553: Identification for Mechanical, Plumbing, and Fire Suppression Systems
7. Section 20 0700: Thermal Insulation for Mechanical, Plumbing, and Fire Suppression

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 SCOPE

A. Work included under Divisions 20 and 23 shall include all labor, services, materials, and equipment and performance of all work required for installation of plumbing systems as shown on Drawings and as specified.

END OF SECTION

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SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:

1. Air Systems:
    a. Constant-volume air systems
    b. Variable-air-volume systems
2. Existing systems TAB
3. Verifying that automatic control devices are functioning properly
4. Reporting results of activities and procedures specified in this Section

1.2 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. 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.

D. 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.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

K. 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.

L. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

M. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

N. 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.

O. TAB: Testing, adjusting, and balancing.

P. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

Q. Test: A procedure to determine quantitative performance of systems or equipment.

R. Testing, Adjusting, and Balancing Firm: The entity responsible for performing and reporting TAB procedures.

1.3 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 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 30 days from Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 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. Warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC, NEBB, or TABB.

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 (7) 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, NEBB or TABB/SMACNA.

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Total System Balance," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification," or the TABB Instrument List.

F. 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.

1.5 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.

1.6 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.

1.7 WARRANTY

A. Provide one of the following performance guarantees:

1. AABC National Project Performance Guarantee
2. NEBB Certificate of Conformance Certification
3. TABB Quality Assurance Program Guarantee

B. 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 - EXECUTION

2.1 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. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, 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.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in General Conditions and Division 01 Section 01 7700, "Project Closeout" and Division 20 Section 20 0500, "Basic Requirements for Mechanical, Plumbing, and Fire Protection.

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 fan and pump curves. 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 heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine equipment for installation and for properly operating safety interlocks and controls.

M. 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 and humidistats 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.]

N. 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.

2.2 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.

2.3 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 Total System Balance," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," or SMACNA's "HVAC Systems – Testing, Adjusting, and Balancing" 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.

2.4 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 air-handling unit components.

L. Check for proper sealing of air duct system.

2.5 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.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
2. Measure static pressure across each component that makes up an air-handling unit, rooftop 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. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. 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.
5. Obtain approval from Engineer 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.
6. 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.
7. Make required adjustments to vane axial fan blade pitch angle to achieve required airflow.
8. Provide sheaves, pulleys and belts required for adjustment of fan speed.

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.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

2.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

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. Re-measure 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.

2.7 PROCEDURES FOR MOTORS

A. Motors, ½ 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.

2.8 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

2.9 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

B. Electric-Heating Coils: Measure the following data for each coil:

1. Nameplate data
2. Airflow
3. Entering- and leaving-air temperature at full load
4. Voltage and amperage input of each phase at full load and at each incremental stage
5. Calculated kilowatt at full load
6. Fuse or circuit-breaker rating for overload protection

C. Refrigerant Coils: Measure the following data for each coil:

1. Dry-bulb temperature of entering and leaving air
2. Wet-bulb temperature of entering and leaving air
3. Airflow
4. Air pressure drop

5. Refrigerant suction pressure and temperature

2.10 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.

2.11 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure and record the static pressure profile throughout each air handling unit (across all components).
3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
4. Check the refrigerant charge.
5. Check the condition of filters.
6. Check the condition of coils.
7. Check the operation of the drain pan and condensate drain trap.
8. Check bearings and other lubricated parts for proper lubrication.
9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows to determine the new fan speed and filter and coil face velocities.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
4. Air balance each air outlet.

2.12 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. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or ungrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

2.13 TOLERANCES

A. Adjust main ducts in air handling systems to ± 5% of design parameters for supply and exhaust/return systems. Adjust individual terminals and branches to ± 7.5% of design conditions for supply and exhaust/return systems. For applications where differential pressures must be maintained, use the following criteria:

Positively pressurized spaces
- Supply air ..... 0 to +10%
- Exhaust air ..... 0 to -10%
- Return air ..... 0 to -10%

Negatively pressurized spaces
- Supply air ..... 0 to -10%
- Exhaust air ..... 0 to +10%
- Return air ..... 0 to +10%

Pressurization (unless noted otherwise)
- Minimum ..... 0.01" w.g.
- Maximum ..... 0.15" w.g.

B. Please note that differentials between supply and exhaust/return airflows, as indicated in the drawings, indicate those spaces with a requirement for differential pressure to be maintained.

C. Adjust hydronic systems to ± 5% of design parameters.

2.14 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.

2.15 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. Pump curves
2. Fan curves
3. Manufacturers' test data
4. Field test reports prepared by system and equipment installers
5. 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. Face and bypass damper settings at coils
e. Fan drive settings including settings and percentage of maximum pitch diameter
f. Inlet vane settings for variable-air-volume systems
g. Settings for supply-air, static-pressure controller
h. 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. Air-Handling 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. Sheave make, size in inches, and bore
i. Sheave dimensions, center-to-center, and amount of adjustments in inches
j. Number of belts, make, and size
k. 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. Starter size, rating, heater elements
f. Sheave make, size in inches, and bore
g. 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 w.g.
c. Fan rpm
d. Discharge static pressure in inches w.g.
e. Filter static-pressure differential in inches w.g.

f. Preheat coil static-pressure differential in inches w.g.
g. Cooling coil static-pressure differential in inches w.g.
h. Heating coil static-pressure differential in inches w.g.
i. Outside airflow in cfm
j. Return airflow in cfm
k. Outside-air damper position
l. Return-air damper position
m. Vortex 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 ft^2
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 w.g.
d. Outside-air, wet- and dry-bulb temperatures in °F
e. Return-air, wet- and dry-bulb temperatures in °F
f. Entering-air, wet- and dry-bulb temperatures in °F
g. Leaving-air, wet- and dry-bulb temperatures in °F
h. Water flow rate in gpm
i. Water pressure differential in feet of head or psig
j. Entering-water temperature in °F
k. Leaving-water temperature in °F
l. Refrigerant expansion valve and refrigerant types
m. Refrigerant suction pressure in psig
n. Refrigerant suction temperature in °F
o. Inlet steam pressure in psig

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification
b. Location
c. Manufacturer
d. Model
e. Coil identification
f. Capacity in Btuh
g. Number of stages

h. Connected volts, phase, and hertz
i. Rated amperage
j. Airflow rate in cfm
k. Face area in sq ft
l. Minimum face velocity in fpm

2. Test Data (Indicated and Actual Values):

a. Heat output in Btuh
b. Airflow rate in cfm
c. Air velocity in fpm
d. Entering-air temperature in °F
e. Leaving-air temperature in °F
f. Voltage at each connection
g. Amperage for each phase

I. 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. Starter size, rating, heater elements
f. Sheave make, size in inches, and bore
g. Sheave dimensions, center-to-center, and amount of adjustments in inches
h. 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 w.g.
c. Fan rpm
d. Discharge static pressure in inches w.g.
e. Suction static pressure in inches w.g.

J. 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 °F
d. Duct static pressure in inches w.g.
e. Air correction factor
f. Duct size in inches
g. Duct area in ft^2
h. Indicated airflow rate in cfm
i. Indicated velocity in fpm
j. Actual airflow rate in cfm
k. Actual average velocity in fpm
l. Barometric pressure in psig

K. 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 ft^2

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. Percent of design airflow
h. Space temperature in °F
i. Inlet static pressure in inches w.g.

L. 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 °F
c. Leaving-water temperature in °F
d. Water pressure drop in feet of head or psig
e. Entering-air temperature in °F

f. Leaving-air temperature in °F
g. Water flow rate in gpm

M. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:

a. Unit identification
b. Location
c. Unit make and model number
d. Compressor make
e. Compressor model and serial numbers
f. Refrigerant weight in lb
g. Low ambient temperature cutoff in °F

2. Test Data (Indicated and Actual Values):

a. Inlet-duct static pressure in inches w.g.
b. Outlet-duct static pressure in inches w.g.
c. Entering-air, dry-bulb temperature in °F
d. Leaving-air, dry-bulb temperature in °F
e. Condenser entering-water temperature in °F
f. Condenser leaving-water temperature in °F
g. Condenser-water temperature differential in °F
h. Condenser entering-water pressure in feet of head or psig
i. Condenser leaving-water pressure in feet of head or psig
j. Condenser-water pressure differential in feet of head or psig
k. Control settings
l. Unloader set points
m. Low-pressure-cutout set point in psig
n. High-pressure-cutout set point in psig
o. Suction pressure in psig
p. Suction temperature in °F
q. Condenser refrigerant pressure in psig
r. Condenser refrigerant temperature in °F
s. Oil pressure in psig
t. Oil temperature in °F
u. Voltage at each connection
v. Amperage for each phase
w. Kilowatt input
x. Crankcase heater kilowatt
y. Number of fans
z. Condenser fan rpm
aa. Condenser fan airflow rate in cfm
bb. Condenser fan motor make, frame size, rpm, and horsepower
cc. Condenser fan motor voltage at each connection
dd. Condenser fan motor amperage for each phase

N. Air-to-Air Heat-Recovery Unit Reports:

1. Unit Data:

a. Unit identification
b. Location
c. Service
d. Make and type
e. Model and serial numbers

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. Starter size, rating, heater elements
f. Sheave make, size in inches, and bore
g. Sheave dimensions, center-to-center, and amount of adjustments in inches

3. If fans are an integral part of the unit, include the following for each fan:

a. Make and type
b. Arrangement and size
c. Sheave make, size in inches, and bore
d. Sheave dimensions, center-to-center, and amount of adjustments in inches

4. Test Data (Indicated and Actual Values):

a. Total exhaust airflow rate in cfm
b. Purge exhaust airflow rate in cfm
c. Outside airflow rate in cfm
d. Total exhaust fan static pressure in inches w.g.
e. Total outside-air fan static pressure in inches w.g.
f. Pressure drop on each side of recovery wheel in inches w.g.
g. Exhaust air temperature entering in °F
h. Exhaust air temperature leaving in °F
i. Outside-air temperature entering in °F
j. Outside-air temperature leaving in °F
k. Calculate sensible and total heat capacity of each airstream in MBh.

O. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make
b. Serial number
c. Application
d. Dates of use
e. Dates of calibration

2.16 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 Engineer.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Engineer.
3. Engineer 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.

2.17 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

SECTION 23 0900
BASIC TEMPERATURE CONTROL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Scope
B. Quality Assurance
C. Specifications
D. Project/Site Conditions
E. Work by Subcontractors
F. Coordinated Work
G. Project Phasing
H. Hazardous Materials
I. Design Submittals
J. Start-up and Testing
K. Guarantee
L. Substantial Completion Submittals
M. Closeout Submittals
N. Record Documents
O. Operating and Maintenance (O&M) Manuals
P. Training
Q. Preventive Maintenance Contract

1.2 SCOPE

A. The purpose of this project is to update, replace and expand the existing energy management and control systems [pneumatic temperature control systems].

B. The work includes the complete installation of an electronic building automation, energy management and temperature control system as identified below:

1. Control for the following systems:

a. Base Bid

(1) Existing Trane BCU to remain and be expanded to include new equipment provided.
(2) Upgrade all graphics on existing PCs at the downtown admin building.
(3) Two packaged RTUs with ERV.

b. Additive Alternate Bid 1

(1) Provide controls and graphics for VAV boxes and Electric Duct Heaters.

c. Additive Alternate Bid 2

(1) Provide integration of garage MAU into BAS system.
(2) Provide gas detection sensors and control interlocks to MAU, wall louver/damper and PRV fan.

d. Additive Alternate Bid 3

(1) Replace control of existing garage PRV fan with new PRV fan.

e. Additive Alternate Bid 4

(1) Replace existing Trane BCU with new Trane SC head end. Integrate all existing and new controls to new system and provide graphic modifications to all PCs at the downtown administration building as require to provide a complete and functional graphical system.

C. Contractor must take special precautions at all times to prevent any damage to Owner's equipment or premises. This Contractor shall be liable for any damage.

D. Contractor shall obtain and pay for all necessary construction permits and licenses.

1.3 QUALITY ASSURANCE

A. The system shall be designed, installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have in-place a support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be the manufacturer=s latest standard design that complies with the specification requirements.

C. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, "Governing Radio Frequency Electromagnetic Interference" and be so labeled.

D. This system shall have a documented history of compatibility by design for a minimum of 10 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing controllers and field panels and extend new controllers and field panels on a previously installed network.

E. The Contractor shall employ specialists in the field of Building Automation Systems including: Programming, Engineering, Field Supervision and Installation. Specialists shall have a minimum of 5 years of experience with Building Automation Systems.

F. The Contractor shall be responsible for all work fitting into place in a satisfactory, neat, workmanlike manner acceptable to the Owner and Engineer.

1.4 SPECIFICATIONS

A. The Contract Documents are to be considered scope in coverage only and do not necessarily show the exact location and details of the work to be installed. It shall be the responsibility of the Contractor to furnish and install the work in conformity with the requirements of these Specifications, the applicable codes, regulations and standards, the best trade practices and to meet with the approval of Owner. If any departures from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted immediately to Engineer for approval.

B. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, this specification shall govern.

C. If the drawings and specifications are in conflict with each other, the more stringent shall apply.

1.5 PROJECT/SITE CONDITIONS

A. Before submitting Proposal, the Contractor shall visit and carefully examine the individual sites so as to familiarize himself with existing conditions, the amount of work required, the working hours and special auxiliary restrictions of the project requirements including storage and delivery of materials.

B. The Contractor shall verify all conditions on the job which may affect the installation of the work, and shall familiarize himself with applicable local and state regulations. Any discrepancies or interferences shall be reported immediately to Engineer. Additions to the contract price will not be allowed when they are due to the failure of the Contractor to carefully inspect existing condition.

C. The submission of a Proposal will be construed as evidence that such examination has been made. Later claims for labor, equipment or material required for difficulties encountered, which could have been foreseen had such examination and evaluation have been, will not be recognized.

1.6 WORK BY SUBCONTRACTORS

A. All Subcontractors to the Contractor shall be approved by Owner.

B. The Contractor shall be totally responsible for his work and all work by his Subcontractors.

1.7 COORDINATED WORK

A. This Contractor shall cooperate with other contractors performing work on this project, or other projects at the site, as necessary to achieve a complete, neatly fitting installation for each condition. To that end, each Contractor shall consult the drawings and specifications, for all trades to determine nature and extent of other work.

1.8 PROJECT PHASING

A. Contractor is responsible for all coordination of demolition and construction phasing required.

1.9 HAZARDOUS MATERIALS

A. If hazardous materials including, but not limited to, asbestos, pollutants, or PCB are in any way suspected, inform Owner immediately and suspend work on that portion of the project.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 DESIGN SUBMITTALS

A. Submit all design submittals within 30 days after award of contract.

1. Submit four copies of all drawings and product data every time a submission is made until final approval.
2. Separate submittals may be made: hardware and software.

B. Engineer shall review and comment on copies submitted.

C. If design does not conform to the design intent, Contractor shall resubmit to Engineer.

1. Owner's contract with Engineer stipulates that a maximum of two submissions of each submittal will be reviewed for design conformity. Additional submissions by Contractor are cause for additional compensation to Engineer. Any such additional compensation to Engineer shall automatically result in a Change Order reducing the Contract Price by the same amount with no change in Contract Time.

D. No construction may begin until the design is approved for conformity with specification's intent by Engineer.

E. Submittals and drawings shall be sufficient to:

1. Show that the intent of the specification has been met.
2. Provide a document for use by Owner showing all equipment incorporated into the system including both new and existing.
3. Provide a document for use by Owner showing all equipment pneumatic and wiring connections of the system for both new and existing equipment.

F. Items to be included in hardware drawings at minimum are:

1. Include a complete bill of material of equipment used indicating quantity, manufacturer and model number and other relevant technical data.
2. Include manufacturer's description and technical data, such as performance curves, product specification sheets and installation/maintenance instructions for the items listed in Division 23 Section 23 0901, "Temperature Control Hardware."
3. Provide each electrically operated device with completely coded interconnection wiring diagrams. Show all termination and wiring numbers.
4. Provide schematic wiring diagrams for each control panel. Show all terminations and wiring numbers.
5. Provide schematic wiring diagrams for all field sensors and controllers.
6. Provide each pneumatic operated device with complete piping diagram.
7. All schematic diagrams shall show both new and existing equipment for a complete control system schematic.
8. Provide system schematic diagrams for air handling units, exhaust/ventilation systems, terminal units, and all other miscellaneous points. Schematics to indicate every monitored/controlled point associated with that system.
9. Provide system riser diagrams showing all controllers, workstations, network wiring, etc.

G. Items to be included in software drawings at minimum are:

1. DDC and ASC Controllers

a. Provide one manufacturer's program manual to Engineer. Manual shall contain complete description of all factory programs furnished and applications programming language.

b. At Engineer's request, provide programming flow diagrams of the applications software.

c. Include a complete description of the operation of the temperature control/monitoring system, including sequences of operation.

(1) Such descriptions are to be in Contractor's own words and not identically repeated from the Drawings.

(2) Where sequences indicate, imply or suggest the use of "look-up" tables based on testing to be performed during the project, Contractor shall include such tables using "best-guess" values as place-holders. Contractor shall use actual measured values as they become available.

d. Provide computer printout of all contractor programming and job database entries for each controller. Printouts should be produced by dumping programs/information directly from controllers.

(1) Where sequences indicate, imply or suggest the use of "look-up" tables based on testing to be performed during the project, Contractor shall include such tables using "best-guess" values as place-holders. Contractor shall use actual measured values as they become available.

e. Provide identification of those portions of the control sequences which are defined and activated by the Operator Workstation.

f. Provide the control loop algorithms/calculations proposed.

g. Provide a controller point list, including both inputs and outputs (I/O), indicating I/O point number, the controlled device associated with the I/O point and the location of the I/O device.

h. Provide schedules, lists or other documentation of all operation parameters.

i. The Contractor shall provide eight (8) hours of labor at Engineer's office for the principal program writer to meet with Engineer to interpret/review line by line programming.

2. Personal Computer/Operator Workstation

a. Provide one manufacturer's program manual to Engineer. Highlight which programs will be activated to meet this specification and which programs will be left inactive.

(1) For those programs which are activated, provide schedules, lists or other documentation of all data which will be entered to customize base programs to this facility.

b. For software written and loaded specifically for this job, provide line by line applications software.

(1) Include a complete description of the operation of each software program. This description shall directly reference the line by line program.

(2) Provide schedules, lists or other documentation of all operation parameters.

(3) Provide sample copies of all logs and reports specified.

3. The Contractor shall provide four (4) hours of labor at Engineer's office for the principle program writer to meet with Engineer to interpret/review line by line programming.

H. No work may begin on any segment (hardware or software) of this project until the design for the respective segment has been reviewed by Engineer for conformity with the specification design intent.

I. Quantities of items submitted will not be reviewed by Engineer and are the responsibility of the Contractor.

J. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Clearly note exact models, options and accessories being provided. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.

K. Drawings and product data not bearing the approval stamp of the Contractor, showing Contractor has reviewed and approved, or containing deviations from the contract documents, will be returned to the Contractor for resubmittal for compliance with above requirements.

L. Equipment furnished and installed which is not reviewed by Engineer and not conforming to the design concept of the project will have to be removed and replaced with acceptable equipment all at the cost of the Contractor.

M. Corrections or changes indicated on drawings and product data shall not be considered as extra work order.

N. Engineer's checking and reviewing of drawings is a gratuitous assistance and in no way relieves the Contractor from responsibility for errors or omissions which may exist on the drawings. Whenever such error or omissions are discovered, they must be made good by the Contractor, without any additional cost to Owner, irrespective of any review by Engineer.

O. Provide to Engineer any additional information or data which they deem necessary to determine compliance with these specifications or which they deem valuable in documenting the equipment to be installed.

3.2 START-UP AND TESTING

A. Where new digital controls are being installed they shall be installed to the greatest extent possible before switch over from the existing temperature control system.

1. Prior to switch over, the controllers shall be completely installed, checked and tested.
2. Controller software and hardware shall be verified prior to switch over.

B. Prior to testing and verifying proper system operation, Contractor shall furnish Engineer, for acceptance, three (3) copies of the start-up/testing procedure proposed. Engineer must approve the check-out procedure prior to start-up/testing.

C. The start-up/testing procedure shall be submitted in writing one (1) calendar month prior to the projected start of start-up/testing.

D. Check out procedure must include provisions for technicians to specifically check off procedures or tests performed.

E. At minimum, the following shall be included in the checkout procedure:

1. The Contractor shall test and verify proper operation for each control loop.
2. Each control loop check will verify that the controller, manual override, fail-safe control and electric interlocks are operating as intended to accomplish the control strategy.

    a. Provide to Engineer trend logs of a minimum of thirty minutes in length, sampling no less frequently than every one minute, registering analog values of controlled variables showing that control loops respond adequately during system start-up as well as steady state conditions. Logs must show the loop response to a step input of at least 5F change in setpoint or 10% relative humidity change in setpoint.

3. Contractor shall test and verify that correct terminations/designations of I/O are in place for each input and output.
4. Contractor shall test and verify that sensors are properly calibrated, operational, and are within the performance parameters established in this specification.

    a. Contractor shall have onsite instrumentation to calibrate/verify all analog input sensing. Instruments shall themselves be properly calibrated and be of greater accuracy than the sensors installed.

5. Contractor shall test and verify onsite that operator interface menus and help screens are properly displayed, and that point names and designations are correct.
6. Contractor shall test and verify communications between controllers.

F. Start-up of the new digital control system must be phased with the phases of construction on this project. Start-up of an individual digital controller shall be planned such that the entire switch-over and checkout of a system can occur in less than one day. Incomplete or unverified controller systems shall not be left in operation overnight without permission of Owner.

1. Contractor will not be allowed to switch over additional systems until the present controller being worked on is 100% complete.

G. After the procedure is approved and after portions of the system are complete (phasing of system installation/commissioning to be approved by Owner) and ready to be placed into regular service, Contractor shall inform Owner of this fact in writing.

H. Contractor shall agree on start-up dates with Owner.

I. On each start-up date for completed portions of the system, Contractor shall have on-site qualified vendor field technicians to place the system in operation, making such tests, adjustments and changes as may be found necessary to insure successful operation of the installed equipment and systems.

J. Contractor shall notify Owner 24 hours in advance when equipment needs to be shutdown during start-up/testing.

K. All tests shall be documented by the Contractor and certified, verifying that the tests have been performed and that all deficiencies have been corrected.

1. Contractor shall demonstrate on site to Engineer that each input and output operates as specified, control loops are tuned, alarms report as specified, failsafe modes are as specified, and other verification as requested by Engineer and/or Owner to demonstrate that the system has been checked by the Contractor.
2. All testing must be performed and all deficiencies corrected to Engineer's and Owner's satisfaction.

L. At the end of each phase of start-up/testing, if equipment and systems are operating in a manner satisfactory to Engineer and Owner, Owner will sign a certificate affirming that the systems operation has been tested and accepted in accordance with the terms of his specification. The date of Owner's final acceptance of the entire system (not phased portions) will be the start of the guarantee period.

3.3 GUARANTEE

A. Workmanship and material for work specified shall be guaranteed free from defects for a period of twelve (12) months after final completion and acceptance by Owner of the entire system, not portions of the system. Note that warrantees for individual controllers placed in service will not commence until the entire system is complete and accepted by Owner. Any equipment herein described that is shown to be defective during the guarantee period shall be adjusted, repaired, or replaced at no charge to Owner.

B. After the final inspection and demonstration, a punchlist of incomplete or unsatisfactory items will be developed by Engineer.

C. The Contractor shall respond to the punchlist with a date by which all items will be completed/corrected.

D. Upon completion of all punchlist items, the Contractor shall inform Engineer in writing of this fact. This date will serve as the tentative guarantee start date.

E. Upon verification that all punchlist items are complete by the Engineer, the tentative guarantee start date will become the actual guarantee start date.

F. Items which unreasonably delay the start of the guarantee and are beyond the Contractor's control such as change orders late in the project will not be considered in establishing the guarantee start date.

G. During the guarantee period, software updates/controller improvements (i.e., microprocessor chip changes) shall be provided to Owner at no charge. Coordinate with Owner prior to the installation of such changes.

Note: The intent of G. is to insure that Owner receives any product updates which are directed toward correcting a product problem which may or may not be apparent. It is not intended to automatically extend to Owner new product features or enhancements which did not exist at the time of Contract Award.

H. At Owner's request, the Contractor shall visit the building to clarify for the operating personnel any questions as to the proper operation and maintenance of the system during the first year after final acceptance of system.

3.4 SUBSTANTIAL COMPLETION SUBMITTALS

A. Contractor shall provide the following documents at the time requesting Certification of Substantial Completion:

1. Documents as described in General Conditions.

2. Dynamic trend graphs of each control loop showing compliance of control algorithm tuning. Show setpoint step-change up and step-change down. Contractor shall ensure that the time and valve scales are sufficiently fine to show compliance.
3. Listing of all changes in sequence of operation from those specified by Owner's direction. Listing shall be signed and dated by Owner.
4. Print-out of each color graphic design.

3.5 CLOSEOUT SUBMITTALS

A. Contractor shall provide closeout submittals required by the Contract Documents including, but not limited to, the following prior to requesting Final Acceptance of the Work:

1. Record Documents as described in Paragraph 3.6 herein;
2. Operating and Maintenance Manuals for items so required by the various Specification Sections and other items as so requested by Owner and as described in Paragraph 3.7 herein;
3. Warranties, guarantees, and bonds as outlined in Paragraph 3.3 of this section;
4. Keys and keying schedule;
5. Tools, spare parts, maintenance stock of materials, etc.;
6. Evidence of compliance with requirements of governmental agencies having jurisdiction including, but not necessarily limited to:
   a. Certificates of Inspection;
7. Certificates of Insurance for products and completed operations;
8. List of subcontractors, service organizations, and principal vendors, including names, addresses, and telephone numbers where they can be reached for emergency service at all times including nights, weekends, and holidays;
9. Verification that all training has been reviewed with Owner personnel as described in Paragraph 3.8 herein;
10. Certified copy of final punchlist of itemized work to be completed or corrected (including equipment requiring final connection), stating that each item has been completed or otherwise resolved for acceptance, endorsed and dated by Owner;
11. Revised evidence of final, continuing insurance coverage complying with the insurance requirements;
12. Final Application for Payment in accordance with the provisions of the Contract Documents;

B. Contractor and all Subcontractors and major material suppliers who have furnished material or labor for the Work under contract with the Contractor or Subcontractor shall submit final lien waivers. The lien waivers shall be for the full amount of the Contract involved.

3.6 RECORD DOCUMENTS

A. General

1. When conflict occurs between various technical specification sections and this Section 23 0900, "Basic Temperature Control Requirements," the more stringent requirements shall govern.
2. Each Contractor shall maintain at the site for Owner one record copy of all drawings, specifications, addenda, approved shop drawings, change orders, and

other modifications, in good order and marked to record all changes applicable to the work made during construction. All changes made during construction shall be recorded by the Contractor. Contractors shall be responsible for accuracy of all changes made.

3. The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.
4. Failure to keep accurate records of equipment installed will require the Contractor to site verify the installation as required, all at Contractor's expense.

B. Recording

1. Legibly mark and record at each Product section of the Project Manual a description of actual Products installed, including the following:
   a. Manufacturer's name and product model and number.
   b. Product substitutions or alternates utilized.
   c. Changes made by Addenda and Modifications.
2. Record Drawings: Legibly mark to record actual construction:
   a. Location of devices (sensors, actuators, controllers, etc.) internal utilities (including conduit routing), and appurtenances, concealed in construction or not readily observable from floor level, referenced to visible and accessible features of structure.
   b. Changes of dimension and detail.
   c. Details not on original Contract Drawings.
   d. Modifications/additions to original electrical and pneumatic interface schematics.

C. Submittal

1. During the first week of each month, Contractor shall present, at the project site, the job copy showing variations and changes to date to Owner for review.
2. At completion of Project, submit two (2) copies on disk of Project Record Documents to Owner. Project Documents shall contain Project Documents indicating all changes made during construction. Accompany submittal with transmittal letter, in duplicate containing:
   a. Date
   b. Project title and address
   c. Contractor's name and address
   d. Title and number of each record document
   e. Certification that each document as submitted is complete and accurate.
   f. Signature of Contractor or his authorized representative.

3.7 OPERATING AND MAINTENANCE (O & M) MANUALS

A. Contractor shall provide four (4) sets of Operating and Maintenance (O&M) manuals to Owner.

B. Contractor shall also provide required quantity of O&M manuals for Owner Training as specified in Paragraph 3.8.

C. The format and information contained in the new O & M manuals will be as follows:

1. Format

a. Binders: Commercial quality, 8½" x 11" three-ring binders with hardback, cleanable, plastic covers; one inch maximum ring size. Use multiple binders as required.
b. Front cover and binding: Identify each binder with typed title.
c. Tab Dividers: Provide tabbed fly leaf for each separate product, system or subject with typed description.
d. Table of Contents: Provide table of contents for each volume.
e. Project Record Drawings: Reduce AutoCAD drawings to 11" x 17" format, provide with reinforced punched binder tab. Bind in with text; fold drawings to size of text pages. (Larger drawing will be allowed if 11" x 17" format is unreadable.)

2. Volume 1 Hardware

a. Section 1:

(1) Include all submittals and drawings updated to as built conditions.
(2) Include manufacturer's operation and installation instructions for items such as modems, printers, CRTs, computers, keyboards, etc.

b. Section 2:

(1) Field hardware, product literature.

c. Section 3:

(1) Controller product catalogs, controller panels, electronic cards, components, etc.

3. Volume 2 Custom Software

a. Section 1 - Software. Provide print outs of all software programming files, including but not limited to all point logs, alarm logs, points with attributes, engineering unit file, programs, message file, etc. Provide software submittals including flow charts and description of operation updated to as built conditions.
b. Section 2 - Control. Provide software submittals including flow charts and description of operation updated to as built conditions.
c. Section 3 - Users Summary Catalog. Provide important information which operators would be expected to use on a day by day basis. Work with Owner in defining exact material to be included in this manual.

D. Provide two (2) copies of all job software on disks which can be directly loaded by Owner.

E. All drawings, applications software and other job documentation will become the property of Owner.

F. Distribution of O&M manuals will be by Owner.

3.8 TRAINING

A. Contractor shall provide a minimum of two (2) training sessions during the Contract period. Training shall be made available to Owner during all three working shifts.

1. Session 1: On Owner project site, minimum of four hours approximately one week following checkout and start-up of first controller.

2. Session 2: Follow-up session, approximately one month after start-up of completed system. Minimum period of sixteen hours.

B. Contractor shall video tape each training session. Provide Owner one copy of all tapes for each session within one week of such session.

C. One month prior to the first session, the Contractor shall provide an outline of all topics to be covered in all sessions for approval by Owner.

D. The instructor(s) shall be competent and have full knowledge of the system installed and shall provide training specifically oriented to Owner's installed system.

E. The instructor(s) shall utilize the operating and maintenance manual provided for the system as a reference manual during the training session. Each person attending the training session shall be provided with an O&M manual. At minimum, these sessions shall include the following:

1. Description of the overall control system configuration and physical layout, indicating location of all sensors and controlled devices.
2. Description of all programs and program features (software).
3. Description of the control strategies being utilized at the installation.
4. Description of all key hardware components utilized in the system.
5. Demonstration of how to communicate with (command and monitor) the DDC and ASC Controller(s).
6. Demonstration of the programming instructions required to use the system.
7. Demonstration of how to retrieve alarms and logs.
8. Demonstration of diagnostic trouble-shooting techniques for the system.
9. Description of any changes made to existing electric and pneumatic controls which remain.
10. Provide quick reference card for operator ease of operation.

END OF SECTION

SECTION 23 0901
TEMPERATURE CONTROL HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General Conditions of the Construction Contract and Supplementary Conditions and Division 01 of the specifications apply to the work in this section.

B. This section is hereby made part of all other sections of Division 23 as fully as if repeated in each.

1.2 SECTION INCLUDES

A. Network Communications

B. Direct Digital Control Controllers

C. Application Specific Controllers

D. Operator Workstation

E. Portable Operator Terminal

F. DDC System Field Hardware

G. Miscellaneous Hardware

1.3 SCOPE

A. This Section establishes a minimum quality of hardware and installation and establishes standard equipment or equipment configurations.

B. The digital control/building automation system shall utilize systems as herein specified and manufactured by the Trane Company.

C. Work installed by the Contractor shall be done in a neat and workmanlike manner, as determined by Owner and in keeping with acceptable standards for this type of work.

D. Unless indicated in this specification, all materials used shall be new. Where items have been indicated to be reused, it is the Contractor's responsibility to insure that the reused items are operating properly and are in good condition. Contractor must make Owner aware of defective items designated for reuse. Owner will be responsible for repairs.

E. Submit data, at minimum, on the following:

1. Direct Digital Control Controllers
2. Application Specific Controllers
3. Network Communications
4. Direct Digital Control and Application Specific Controller Accessories
    a. Modem
    b. Battery
    c. I/O Point Termination Modules
    d. Output Status
    e. Means of Manual Control
    f. Communication Boards
    g. Enclosures
    h. Flow Sensors and Transducers

i. Autozero Modules
j. Electronic Damper Actuators

5. Field Interface Panels
6. DDC Field Hardware
   a. Sensors, including supporting documentation
   b. Transmitters
   c. Utility Interfaces
   d. Switches
   e. Relays
   f. Solenoid Air Valves
   g. Transducers
   h. Freezestats
   i. Power Supplies
7. Miscellaneous Hardware
   a. Electrical Surge Suppressor
   b. Damper End Switches
   c. Low Limit Thermostats
   d. High Limit Duct Humidistats
   e. Air Pressure Safety Switches
   f. Electric HOA Switches
   g. Pneumatic Gradual Switches
   h. Pneumatic Three-Way Switches
   i. Solenoid Air Valves
8. Operator Workstation
   a. Personal Computer, Monitor, Keyboard, Mouse
   b. Printer
   c. Modem
9. Portable Operator Terminal
10. Portable Operator Interface Devices

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROLLERS

A. The following controllers are to be used for this project. All required Bids must include the system configuration as outlined below for each respective vendor. Failure to provide the configuration described shall be grounds for rejection of bid.

1. Voluntary Alternate Bids may be submitted for consideration for alternative network architectures, system configurations and/or controllers.
2. Trane Company:
   a. System Architecture: BCU or SC (alternate)
   b. Direct Digital Controller: Controller determined by application
   c. Network Communications:
      (1) Peer-to-Peer Building Level: Ethernet
      (2) Local Area Network: LON and/or BACnet

2.2 NETWORKING COMMUNICATIONS

A. The design of the overall system shall network operator workstation(s), stand-alone DDC Controllers and stand-alone Application Specific Controllers.

B. The network architecture shall consist of at least two levels: A high performance peer-to-peer building level network and a lower performance local area network.

C. Access to either network shall be totally transparent to the user when accessing data or developing control programs.

D. Peer-to-Peer Building Level Network

1. All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, and execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time. Network shall support a minimum communications speed of 100 Kbps.
2. The network shall support a minimum of 50 DDC Controllers and multiple Operator Workstations.
3. Each PC workstation shall support a minimum of 4 peer-to-peer networks, either by hardwired connection or dial-up modem.
4. The system shall support integration of third party systems (lighting, chiller, boiler, etc.) via panel mounted open protocol processor. This processor shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.

E. Local Area Network

1. This level of communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data. A minimum speed of 4,800 Kbps shall be supported.

F. Telecommunication Capability

1. Auto-dial and auto-answer communications shall be provided to allow DDC Controllers to communicate with remote operator stations and/or remote terminals via telephone lines.
2. Auto-dial DDC Controllers shall automatically place calls to workstations to report alarms or other significant events. The auto-dial program shall include provisions for handling busy signals, "no answers" and incomplete data transfers.
3. Operators at dial-up workstations shall be able to perform all control functions, all report functions and all database generation and modification functions as described for workstations connected via the network. Routines shall be provided to automatically answer calls from remote DDC Controllers. The fact that communications are taking place with remote DDC Controllers over telephone lines shall be completely transparent to an operator.

2.3 DDC CONTROLLERS

A. DDC Controllers shall be 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors,

communication controllers, hardware-based real time clock, power supplies and input/output (I/O) point termination modules.

B. Each DDC Controller shall support a minimum of two (2) Local Area Networks.

C. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:

1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system
4. Supervisory control of all ASC Controllers
5. Historical/trend data for points specified
6. Maintenance support applications
7. Custom processes
8. Operator I/O
9. Dial-up communications
10. Manual override monitoring

D. DDC Controllers shall provide a minimum of two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of devices without interrupting the normal operation of permanently connected modems, printers or terminals.

E. A sufficient number of DDC Controllers shall be provided:

1. To meet the input/output capacity requirements,
2. To meet the minimum requirements of the DDC Riser Diagram shown on the Drawings, and
3. To ensure that none is overloaded. "Overloaded" is defined as a condition where the DDC Controller cannot update all input values, calculate control outputs and execute all control functions within two (2) seconds.

F. Expansion of the DDC Controller I/O capacity through the use of expansion panels, expansion modules, I/O boards, etc., shall be allowed provided:

1. Capabilities of the expansion system are identical to the base DDC Controller.
2. Communicates with the base DDC Controller over a unique internal bus, separate for the peer-to-peer building level network and the local area network.
3. Relies on the micro-processor within the DDC Controller for all processing requirements.
4. Base DDC Controller does not become overloaded.
5. Where the expansion panel is physically located out of sight of the DDC Controller, provide a communication port for a portable operator terminal at every such expansion panel, unless otherwise noted on the Drawings. Such port shall be an extension of the same port as on the base DDC Controller and shall have the same capabilities.
6. Uses the same I/O termination modules as used for the base DDC Controller.

G. Each DDC Controller shall be capable of sharing point information with other DDC Controllers connected on the same network, such that control sequences executed at one DDC Controller may receive input signals from sensors connected to other DDC

Controllers within the network. If the network communication link fails or the original DDC Controller malfunctions, the control loop shall continue to function using the last value received from the failed DDC Controller.

H. Except as noted on the Drawings as "global points," or "remotely connected points," all points for a system shall be physically connected to the same DDC Controller as where its system software resides.

I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587, latest edition.

2.4 APPLICATION SPECIFIC CONTROLLERS

A. Application Specific Controllers (ASC) shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network, either DDC or ASC controllers.

B. ASC Controllers shall be grouped into two categories.

1. Central Systems

a. To be used for air handling units, chiller plants, boiler plants, heat exchanger systems.

2. Terminal Equipment

a. To be used for variable air volume boxes, constant air volume boxes, dual duct terminal boxes, fan coil units, unit ventilators, heat pumps.

C. Where specifically identified to be used on the Drawings, all ASC Controllers used within the same category shall be the same product.

D. Shall be a micro-processor based, multi-tasking, real-time digital control processor.

E. Shall include all point inputs and outputs necessary to perform the specified control sequences.

F. Shall support its own real-time operating system. Provide a hardware-based real time clock with battery backup to allow for stand-alone operation in the event communication with its supervising DDC controller is lost and to insure protection during power outages.

G. All programs shall be field-customized to meet the control sequences specified.

H. Programming of all ASC Controllers shall utilize the same language and programming interface.

I. Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.

J. Provide the following for Terminal Equipment ASC Controllers:

1. Flow sensor and transducer
2. Autozero module for air flow correction
3. Electronic damper actuator

2.5 DDC CONTROLLERS AND APPLICATION SPECIFIC CONTROLLERS - GENERAL

A. Controllers shall be the latest versions available utilizing most recently updated software and hardware offered by the manufacturer

B. Each controller shall support firmware upgrades without the need to replace hardware.

C. Each controller shall act as a stand-alone unit; it shall not be dependent on another controller.

1. Each controller shall function as the system coordinator for the equipment management functions, control peripheral devices and perform all necessary calculations.
2. Each controller shall be independently programmed, with all operating and applications software residing within the unit.
3. All real-time control functions shall be resident in the DDC and ASC Controllers to facilitate greater fault tolerance and reliability.

D. Each controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components and connected sensors. The controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

E. All controllers shall be UL-listed.

F. Provide all processors, power supplies, communications controllers, etc., so that the implementation of a point only requires the addition of the appropriate point sensor, point I/O termination module, wiring or pneumatic tubing, and software programming.

G. Every field point must be associated with a unique I/O point address. No multiplexing schemes are allowed.

H. Controllers shall be furnished in an all steel enclosure with baked enamel finish, NEMA type 1, UL-approved enclosure with a hinged access door and keyed latch. The enclosure shall be sized for sufficient mounting space of additional point termination modules to meet the required spared points and points designated on the Drawings as "future." The lock shall be keyed consistent with the all other Controllers and all field interface panels. Provide protected utility outlet. Controllers meeting these criteria may be directly-mounted. All other Controllers shall be mounted within such an enclosure.

Exception: A non-metallic enclosure furnished by the controller manufacturer may be provided when it can be demonstrated to the Owner that it:

1. Provides adequate protection for the mounting location.
2. All controller devices, such as point termination modules, power supplies, controller modules, communications modules, etc., are enclosed within the controller.
3. All wiring, tubing and their terminations are enclosed within the controller or an external cable trough.

Exception: Controllers mounted above the ceiling do not require keyed locks.
Exception: Terminal Equipment ASC Controllers do not require utility outlet.

I. Where two (2) or more units of the same class of equipment are required, these shall be the same products of a single manufacturer. However, the component parts of the system need not be the products of a single manufacturer.

J. Provide battery backed-up RAM memory and real time/calendar clock. The battery should have minimum five year shelf life so that replacement is infrequent. In the event of power failure, the operating system, application database, stored data and real time/calendar clock should be maintained intact for a minimum of 72 hours.

K. Power Failure and Restart

1. In the event of the loss of AC power to the controller, there shall be an orderly shutdown to prevent the loss of database or operating system software.
    a. Control sequences shall go to the normal system shutdown conditions.
    b. Non-volatile memory shall be incorporated for all critical controller configuration data. Battery back-up shall be provided to support the real-time clock and any critical data which may be in volatile memory, for a minimum of 72 hours.
2. Upon restoration of normal power, after a minimum off time delay, the controller shall automatically resume full operation without manual intervention. Input values and set points received from other controllers shall have default values setup in the event communication is lost between controllers.
3. Should the controller memory be lost for any reason, the Operator Workstation shall automatically reload the program and databases. Such reloading shall be transparent and without any intervention by the system operators.
    a. The system operators shall also have the capability of reloading the controller via the peer-to-peer building level network, via the local area network, via the local RS-232C port, or via telephone line dial-in.

L. Each controller shall be installed such that at least 20% spare capacity of each unique input and output is provided. In other words, if a controller requires 10 analog inputs (8 defined points plus 2 future points), capacity for 12 must be provided; two will remain as spare points.

1. This rule applies for all Base Bids, Alternates Bids and designated future points.
2. Input/output point termination modules to satisfy spare point requirements do not need to be provided. However, adequate space for them does need to be provided.

M. Terminations

1. Wiring to and from the controller shall be to terminal strips with screw type terminals. The use of wire nuts or crimped connections within the controller shall be minimized and will only be allowed if the device has fixed length leads pre-attached by the manufacturer. Wire nuts are applicable only to line voltage circuits. Crimped connectors are applicable to non-analog low voltage circuits.
2. All wiring within the controller shall be run in plastic wiring duct to give a neat and workmanlike appearance.
3. Every device and field termination shall be labeled using words, letters or numbers with permanent, mechanically fabricated or printed, laminated tags exactly corresponding to as-built drawings.

N. Input/Output Electrical Protection

1. All inputs and outputs (analog and binary) shall be protected, at minimum, to withstand 120VAC continuously without damage to the controller. Protection shall conform to IEEE Standard 587, latest edition, and shall be provided at field point terminations and at controller terminations.
2. Provide electrical surge protection on power and communications wiring to and from the controller.

3. This electrical protection includes any input or output supplied, whether or not it is utilized in meeting this specification.

O. Output Status

1. All outputs shall have a visual indication of their status without the need for an operator I/O device. Binary outputs shall use a light emitting diode (LED). Electrical analog outputs shall use a voltmeter, ammeter or LED bars. Pneumatic analog output indication shall be with pressure gauges or LED bars.
2. Applies to DDC Controllers, Application Specific Controllers and Field Interface Panels.

2.6 OPERATOR WORKSTATION

A. Existing Operator Workstations (4) in the downtown Admin Building.

2.7 DDC SYSTEM FIELD HARDWARE

A. Field Interface Panel

1. All field interface devices, where practical shall be mounted in field interface panels. All other field interface devices shall be mounted at the point of field interface in a separate enclosure suitable for the location. When the manufacturer provides an enclosure/packaging of the device or sensor suitable for the location that protects the device from dust and moisture, conceals integral wiring and moving parts, this enclosure shall be acceptable.
2. Mounted within the field interface panel shall be power supplies for sensors, interfacing relays and contactors, pneumatic to electric and electric to pneumatic transducers, output status indication, manual override switches, etc.
3. Provide an enclosure meeting the same requirements as DDC Controllers and Application Specific Controllers.
4. No power line carrier type interfacing equipment will be allowed in the field interface panel.
5. Terminations

a. Wiring to and from the field interface panel shall be to terminal strips with screw type terminals. Analog or communications wiring may use the field interface panel as a raceway without terminating. The use of wire nuts or crimped connections within the field interface panel shall be minimized and will only be allowed if the device has fixed length leads pre-attached by the manufacturer. Wire nuts are applicable only to line voltage circuits. Crimped connectors are applicable to non-analog low voltage circuits.
b. All wiring within the field interface panel shall be run in plastic wiring duct to give a neat and workmanlike appearance.
c. Every field interface device and every field termination shall be labeled using words, letters or numbers with permanent, mechanically fabricated or printed, laminated tags exactly corresponding to as-built drawings.

B. Analog Input Devices

1. Contractor shall provide equipment for analog inputs as indicated in the point lists and shown on the Drawings. This shall include the sensor and transmitter.

2. Sensors and transmitter provided shall be of the type that is universally accepted in the industry, can easily be second-sourced and could be utilized with the majority of digital controller manufacturer's equipment.
3. All sensors and transmitters utilized in a similar application shall be of the same manufacturer.
4. Sensing ranges and accuracies given are for the normal values anticipated. The actual sensor range will be dictated by the maximum and minimum sensed values anticipated and standard sensor ranges.
5. All sensors shall be calibrated at the midpoint of the expected sensed values.
6. Sensor/transmitter shall be appropriately packaged for the location, as follows:
    a. Architectural housing for space wall mounting.
    b. Weatherproof and sun shield housing for outside mounting.
    c. Thermal well housing for water applications.
    d. Dust and physical protective housing for duct mounting.
7. Sensor/transmitter shall be appropriately selected to withstand ambient conditions, such as:
    a. Moisture or condensation, where it is a factor.
    b. Vibration from ductwork, equipment, etc.
    c. Reasonably expected transient conditions such as temperatures, pressures, humidity, etc., outside the normal sensing range.
8. Sensor/transmitter shall be appropriately selected to most closely match the expected sensing range.
9. Sensor/transmitter shall be appropriately selected for an accurate, responsive, and noise free signal.
10. The system shall maintain the specified end-to-end accuracy, indicated below for the noted range, throughout the guarantee period from sensor to controller read-out.
    a. Sensing accuracy shall be determined by the square root of the sum of the errors squared. All sensing errors introduced, including but not limited to, sensor accuracy as manufactured, repeatability, self heating, linearity, thermal drift, lead length, analog to digital conversion, annual sensor drift, etc., shall be taken into account.
    b. Contractor must submit all accuracy information required to prove that sensing accuracy provided will not exceed that specified.
        (1) Supporting documentation that solely indicates a percentage, without indicating what it is a percentage of (i.e., span, reading, etc.) will not be acceptable.
11. Sensor power supplies shall be located in Controller Panels or Field Interface Panels.
12. Temperature Sensor Assemblies
    a. Temperature sensing shall be with RTDs with matched transmitters. Thermistors, nickel and silver elements, thermocouples or pneumatic transmitters shall not be allowed.
    b. The assembly shall consist of a 1,000 ohm platinum RTD and a solid-state, 2-wire, 4-20mA transmitter. The transmitter shall be compatible

with the temperature element and the DDC panel. The assembly shall be factory calibrated over the entire operating span.

c. End-to-end accuracies shall be as follows:

Application	Accuracy	Range
Duct	± 0.50°F	40°F - 120°F
Outside Air	± 1.0°F	-30°F - 120°F
Space	± 0.50°F	50°F - 90°F

d. Manufacturers: Hy-Cal, Minco or approved equal.

e. Air Stream, Averaging

(1) The assembly shall consist of an averaging type sensor housed in a flexible sheath with a housing suitable for duct mounting.
(2) Probe length: 1 ft. per 4 sq. ft. of duct area.
(3) Averaging temperature sensors shall be used for mixed air temperature measurements and as shown on the Drawings.
(4) Provide sensor/transmitter as specified above.

f. Air Stream, Non-Averaging

(1) The assembly shall consist of an 18" probe with a housing suitable for duct mounting.
(2) Probe length: 18" or half the duct diameter, whichever is smaller. Mount where directed at a location in which no stratification exists.
(3) Provide sensor/transmitter as specified above.

g. Outside Air

(1) The assembly shall be mounted in a housing suitable for outdoor installation. The sensing element shall be installed in a weatherproof aspirating enclosure.
(2) The assembly shall be installed in a location such that the effects of heat radiated from the building or from sunlight are minimized.
(3) Provide sensor/transmitter as specified above.
(4) Outside air temperature sensors shown in outdoor air intake ducts shall meet the specifications for Temperature Sensor Assembly - Air Stream, Non-Averaging, except that the accuracy and range shall be as specified for Outside Air.

h. Space

(1) The assembly shall consist of a decorative ventilated enclosure acceptable to Owner.
(2) Provide sensor/transmitter as specified above.
(3) In addition, provide the following for space sensors used with Terminal Equipment ASC Controllers:

(a) Digital temperature display
(b) Set point adjustment
(c) Override button to activate "day" sequences and set points during after-hours.

(d) Phone jack connection for the Portable Operator Terminal to allow operator to interrogate, change and command set points, flow limits, airflow rates, etc.

13. Relative Humidity Sensor Assemblies

a. Relative humidity sensing shall be temperature compensated, monolithic bulk polymer integrated circuit humidity sensing.

b. The assembly shall consist of humidity sensor with a solid state, two wire 4-20 MA transmitter matched to the sensing element. The assembly shall be factory calibrated.

c. The output shall be linearly proportional to 0-100% relative humidity.

d. The transmitter shall have non-interactive zero and span adjustments, adjustable from the outside cover.

e. Assembly shall have the ability to be field calibrated without disturbing operations using a single point electronic field calibrator.

f. Where periodic cleaning of the sensing element is required or recommended by the manufacturer, mount in a manner which will allow easy removal and replacement.

g. End-to-end accuracy shall be as follows:

Range	Accuracy
0% - 20% RH	± 3% RH
20% - 90% RH	± 2% RH
90% - 100% RH	± 3% RH

h. Long-term stability of the assembly shall be less than ± 1% RH per year.

i. Manufacturers: Vaisala, General Eastern, or approved equal.

j. Space

(1) Mounted in a decorative ventilated enclosure suitable for wall mounting and acceptable to Owner. Enclosure styling shall be similar to space temperature sensors.

k. Duct Mounted

(1) Provide duct-type stainless steel sensing probes and fully gasketed housing suitable for duct mounting.

l. Outside Air

(1) The assembly shall be mounted adjacent to the outside air temperature sensor in a housing suitable for outdoor installation. The sensing element shall be installed in a weatherproof aspirating enclosure.

(2) The assembly shall be matched to the respective sensing element. The assembly shall be factory calibrated to an accuracy of ± 2% RH over the entire operating span.

14. Combination Temperature and Relative Humidity Sensor Assemblies

a. Combination temperature and relative humidity sensor assemblies may be used for the following applications provided the above specifications for each portion of the assembly are met.

(1) Outside Air

(2) Return Air

15. Pressure Sensor Assemblies

a. The assembly shall consist of a pressure transducer with a solid state, two wire, 4-20 MA transmitter mounted in one housing.
b. The transmitter shall be matched to the respective sensing element.
c. The transmitter shall have non-interactive zero and span adjustments, adjustable from the outside cover.
d. The transmitter shall be capable of continuously withstanding an over pressure of at least two times the operating range without changing performance, accuracy or repeatability.
e. The transmitter shall be capable of continuously withstanding an over pressure of at least five times the operating range without rupturing.
f. Provide shut-off valves for all connections to facilitate servicing. Provide bypass valve assembly, including air bleed units and bypass valve, for all wet connections.
g. Provide tee taps for gauge connections when calibrating.
h. Provide expansion/contraction loops as required.
i. Provide duct static traverse probes, as required, to monitor duct static pressure. Probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe.
j. Provide shielded static pressure probe at each end of building differential pressure sensors. Probe shall have multiple sensing ports, impulse suppression chamber and airflow shielding. Provide suitable probes for indoor and outdoor locations.
k. End-to-end accuracies of the assembly shall be as follows:

Application	Accuracy	Range
Air		
Building static	± 0.001" w.c.	± 0.10" w.c.
Duct static	± 0.05" w.c.	0 - 5" w.c.
Other ± 1.0% full scale	as required	

l. Manufacturers: Setra, Ashcroft, Robinson-Halpren or approved equal.

16. Current Measurement (Amps)

a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal which will be converted to a 4-20 mA DDC compatible signal for use by the system.
b. Current Transformer. Provide a split core current transformer to monitor motor amps.
   (1) Operating frequency - 10 - 80 Hz
   (2) UL recognized
   (3) Five amp secondary
   (4) Select current ratio as appropriate for application.
c. Current Transducer. Provide a matching current to voltage or current to mA transducer and power supply. Current transducer shall include:
   (1) 6X input over amp rating for AC inrushes of up to 120 amps.
   (2) Manufactured to UL 1244.

(3) Accuracy: ± 0.5% of full scale, Ripple ± 1%.

d. When used for pump or fan status, differentiate signal between off, on with no load, and on with load (high and low speeds).

e. Manufacturers: Veris Industries or approved equal.

17. VFD Speed Feedback

a. Provide signal indicating actual variable frequency drive speed.

b. Provide all interface devices as required.

18. Highest Zone Thermostat Pressure

a. Obtain pneumatic control signal from existing pneumatic signal selector.

b. Verify calibration and setpoint for each existing thermostat connected to the signal selector.

C. Analog Output Devices

1. Contractor shall provide equipment for analog outputs as indicated in the point list and shown on the Drawings. This shall include digital to analog conversion and wiring or pneumatic tubing to the controlled device. When necessary, the analog output signal must be fed back and used in the control algorithm.
2. All controlled devices which are to be modulated are to receive analog signals of one of the following forms: 0-20 psi, 3-15 psi, 4-20 MA, 0-5 VDC or 0-10 VDC.
3. Analog output signal for variable frequency drives shall be 0-10 VDC.

D. Binary Input Devices

1. Contractor shall provide equipment for binary inputs as indicated in the point lists and shown on the Drawings.
2. All binary shall be electrically isolated from the digital controller either by optical isolation or relays. Provide filtering to eliminate false signals resulting from input "bouncing."
3. All binary inputs shall be provided by double or single pole-double throw dry contacts wired Normally Open (NO) or Normally Closed (NC) as required. All binary inputs will be wired to alarm on "out of normal" conditions.
4. Status Relay. Relays shall be located in the field interface panel or in the monitored equipment's control panel. These relays shall be of the sealed, multiple pole type with socket mount. These relays shall have silver cadmium contacts with a minimum life of one million operations. Contact rating shall be 5 amps at 110 volts resistive. Provide Potter Brumfield, Allen Bradley or approved equal.
5. Current Status Switch

a. Self-powered current sensing consisting of a current transformer, solid state current sensing circuit, adjustable trip point, solid state switch, dry contact SPDT relay and separate LEDs indicating the power and sensor trip status.

b. Unit shall be capable of detecting belt loss, belt failure, motor failure and other mechanical failures.

c. Unit will be accurate to within ± 1% of range.

d. Unit shall be suitable for variable frequency drive applications.

e. A conductor of the load shall pass through the window of the device. Device shall be able to accept up to twice its trip point range.

f. Shall be used for all fan and pump status points, unless otherwise noted on the Drawings.

g. Manufacturers: Veris Industries or approved equal.

6. Air Filter Status Switch

a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120 VAC.

b. Provide complete installation kit including: static pressure tips, tubing, fittings and air filters.

c. Provide appropriate scale range and differential pressure adjustment for intended service.

d. Manufacturers: Penn P32 or approved equal.

7. VFD Fault Status

a. Provide status indication of the variable frequency drive being in a fault condition.

b. Obtain contact closure from variable frequency drive.

8. VFD Manual/Bypass Status

a. Provide status indication of the variable frequency drive placed into manual control mode or in bypass mode.

b. Obtain contact closure from variable frequency drive.

E. Binary Outputs

1. Contractor shall provide equipment for binary outputs as indicated in the point list.

2. For all binary outputs to inductive loads such as relay, solenoid, or motor coils, transient voltage suppression shall be placed across the binary output relay contacts.

3. Binary outputs shall be wired/piped normally open or normally closed for proper operation and failsafe operation.

4. Control relays shall be located in the field interface panel. These relays shall be of the sealed, multiple pole type with socket mount. These relays shall have silver cadmium contacts with a minimum life of one million operations. Contact rating shall be 5 amps at 110 volts resistive. Provide Potter Brumfield, Allen Bradley or approved equal.

NOTE: No inductive or switching loads shall be mounted in the same enclosure as digital controllers.

2.8 MISCELLANEOUS HARDWARE

A. Damper End Switch

1. Shall be oil tight, roller type, SPDT snap acting switch.

2. Contact rating: 5 amps at 110 volts resistive.

3. Mechanism to provide ample over travel to prevent stress on damper and control equipment.

4. Manufacturers: Furnas Electric or approved equal.

B. Low Limit Thermostat

1. Shall have a 20 foot flexible vapor charged element. When temperature sensed by any 12" segment of the element falls below set point (usually 40°F), the thermostat shall operate DPDT contacts as required.
2. Contact rating: 5 amps at 110 volts resistive.
3. Manual reset.
4. Mount in serpentine fashion across coil inlet top to bottom.
    a. Provide a minimum of one such thermostat for each coil section in multiple coil section air handling units.
    b. Provide additional switches as required to provide full protection of the air stream.
5. Manufacturer: Johnson Controls A-70 or approved equal.

C. High Limit Duct Humidistat

1. Shall be insertion type, reverse acting with proportional control.
2. Operating range shall be 50% to 90% relative humidity.
3. Manufacturer: Johnson Controls H-3610 or approved equal.

D. Air Pressure Safety Switches

1. Air pressure safety switches shall be of the manual reset type with DPDT contacts rated for 2 amps at 120 VAC.
2. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

PART 3 - EXECUTION

3.1 DDC AND APPLICATION SPECIFIC CONTROLLERS

A. General

1. The control system will be turned over to Owner in complete operating order. All new hardware will be checked, calibrated, and adjusted for immediate use. All software required will be turned over to Owner ready for use, including all operating parameters, set points, and schedules.
2. Each controller will operate as a stand-alone unit such that it does not require any other unit or any operator interface to be on-line to perform its specified functions.
3. Provide control inputs and outputs as indicated on the point lists.
4. For each input point, provide the required field hardware necessary to provide the listed input point to interface to its respective control panel.
5. For each output point, provide all control devices required to provide proper control of the point.

B. Controllers are to be powered by individual 120/1/60 power circuits.

1. Obtain power from same type of source (normal or emergency) as the system(s) being controlled the nearest emergency power circuit. Where controller serves multiple systems on both normal and emergency power, power shall be obtained from an emergency power circuit.
2. A separate third wire (independent grounding wire) shall be furnished as part of the control panel power circuit.

3. Provide a fused disconnect at each controller panel. Non-control loads are not to be on this circuit.
4. Each panel shall be protected by an electrical power surge protector.

NOTE: No inductive or switching loads shall be mounted in the same enclosure as the Controller. This is to eliminate any chance for electrical interference with the Controller.

NOTE: No line voltage power may be directly connected to the input/output terminal strip.

5. Terminal Equipment ASC Controllers may share a common circuit.

C. Before mounting each panel, the Contractor shall examine the mounting location for exposure to water leakage. Panels shall not be located directly below or next to any piping valve or accessory which might leak or require servicing. Mounting location shall provide full accessibility to the panel.

D. Panel shall be mounted to a permanent wall or it shall be mounted on a free standing, unistrut type support system.

E. The panel shall be labeled using one inch plastic engraved tags. Every termination to the panel shall be labeled with mechanically fabricated or mechanically printed letters, numbers, etc., which exactly correspond to as-built drawings.

F. Provide typewritten point list at each new controller.

G. Electrical Interference

1. The Contractor will follow the equipment manufacturer's recommendations and incorporate shielding to insure that the electronic control system does not experience any supply voltage transients or electromagnetic interference.
2. Should the system fail to operate satisfactorily due to any electrical interference, the Contractor will take corrective action at no charge to Owner. This will remain in effect until the end of the warranty period.
3. The Contractor shall install all equipment in a manner such that it is not adversely affected by electromagnetic noise. If so, the Contractor shall make any necessary corrections.
4. The Contractor shall install all equipment in a manner such that it does not produce electromagnetic noise which affects other equipment located at this facility. If so, Contractor shall make any necessary corrections.

3.2 OPERATOR WORKSTATION

A. The Operator Workstations four (4) are existing. All software required or version upgrades required shall be loaded and turned over to Owner ready for use, including menus, alarms, graphic screens, etc.

3.3 DDC SYSTEM FIELD HARDWARE

A. Field Interface Panel

1. The panel shall be firmly attached to a permanent wall or it shall be free standing from unistrut type supports. It shall be mounted directly adjacent to the controller panel.
2. Provide individual 120V power circuits to each panel. A separate third wire (independent grounding wire) shall be furnished as part of the field interface panel power circuit. Power source shall be the same as the controller.

3. Provide a fused disconnect at each panel. Non-control loads are not to be on this circuit.

B. Sensors

1. Space sensors on exterior walls shall be mounted on an insulated backplate and the hole into the wall completely sealed. If conduit is used up to the device, the conduit shall be plugged with insulation to prevent cold air from entering the device.
2. Space sensors shall be mounted 4'0" above the finished floor line or in line with existing devices.
3. When installing space sensors, the Contractor shall examine the actual locations of air distribution diffuser. Obtain Owner's approval as to the location of all space sensors.
4. All water temperature sensors shall be installed in wells.
5. Outside air temperature sensors shall be mounted on the exterior wall in a weather and sun shield and shall be located to provide accurate outside air temperature sensing. Outside air sensors are to be installed such that they point up to prevent the sensor housing from filling with water.
6. Outdoor air humidity sensor shall be located next to the outdoor air temperature sensor as indicated on plans.

3.4 MISCELLANEOUS HARDWARE

A. Miscellaneous hardware shall be installed as per manufacturer's recommendations.

B. Thermostat and switch set points shall be set by the contractor to an appropriate level for the application.

END OF SECTION

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SECTION 23 0902
TEMPERATURE CONTROL SOFTWARE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. DDC and ASC Controller Software Description

B. Operator Workstation Software Description

C. DDC System Point List

D. Alarm, Trend Log, Totalization Lists

E. Color Graphics

F. Control Sequences of Operation

G. Control System Failures

1.2 SCOPE

A. All necessary software to form a complete operating system as described in this specification shall be provided.

1.3 SUBMITTALS

A. Comply with pertinent provisions of the Project Manual.

B. Submit data on the following:

1. DDC and ASC Controller Software Capabilities
2. Operator Workstation Software Capabilities
3. DDC System Point List
4. Job Specific Software Data Bases
5. Control Software Programs and Flow Charts
6. Control Sequences of Operation

PART 2 - PRODUCTS

2.1 CONTROL SOFTWARE DESCRIPTION

A. General

1. The software programs specified in this section shall be provided as an integral part of the DDC and ASC controllers and shall not be dependent upon any higher level computer for execution.
2. The Contractor shall work with Owner to enter all operating information for software provided, such as point name descriptions, passwords, etc., such that at job finalization, all this information is entered. The Contractor shall be responsible for this information being completely entered and documented before job finalization.
3. Provide software required to meet the control strategies and performance described in this Section.
    a. Owner reserves the right to make changes in the software control strategies and sequences at the time of approval of the software submittals without change in cost to Owner.

4. Software shall be turned over to Owner, complete and ready for operation. Operator entered parameters shall be entered as shown. When not indicated, submit a written request for values to Owner.
5. Note that all setpoints and time delays shall be operator adjustable. Coding Setpoint values into the programming is not allowed.
6. The Operator shall have the ability to custom program any control program software online.
    a. The custom programming package shall provide online process text editing. This capability shall allow creation, addition, deletion, or modification of a program.
    b. The custom programming package will verify operator inputs to insure there are no language errors. All errors found shall be identified to the operators.
    c. Software shall be segmented such that editing of one program does not affect other programs.
7. The Operator shall have the ability to online interrogate or modify setpoints and parameters of any controller.
    a. The Operator shall be able to identify field points by a short name and shall not require look-up charts to call up a specific point.
    b. All displayed field points, parameters or setpoints shall be shown, properly scaled with correct engineering units.
    c. All analog values shall show scale such as degrees F, percent RH, etc. All binary points shall indicate status such as on/off, open/closed, etc.
8. The software provided shall be programmed to create a system in which the network architecture is invisible to the operator. The operator shall be able to monitor point statuses, etc., without the need for referencing hardware point locations in controllers.

B. Pre-tested Control Algorithms. The DDC and ASC Controllers shall have the ability to perform the following pre-tested control algorithms as required:
1. Two Position Control
2. Proportional (P) Control
3. Proportional plus Integral (P+I) Control
4. Proportional, Integral, plus Derivative (P+I+D) Control
5. Automatic Control Loop Tuning

C. Control Algorithm Tuning. The Contractor shall tune control algorithm to actual conditions such that all control sequences are stable, yet control gain is maximized.
1. Two Position and Proportional Control
    a. Control loops for space temperature shall not over or under shoot by more than 2°F on start-up conditions.
    b. Control loops for humidity shall not over or under shoot by more than 10% relative humidity on start-up conditions.
    c. Control loops for duct temperature shall not over or under shoot by more than 5°F on start-up conditions.
2. P+I and P+I+D Control and Automatic Control Loop Tuning

a. Control loops shall be tuned to achieve both short-term response and long-term stability.

b. Short-Term Response:

(1) Controlled variable shall achieve 80% of a step-change in setpoint within the time shown below. The acceptable number of cycles of over- and under-shoot (error) are as shown below.

(2) Controlled variable shall achieve 100% of a step-change in setpoint and stabilize within the time shown below. The acceptable number of cycles of over- and under-shoot (error) are as shown below.

(3) All control loops shall be tested and tuned to achieve the above requirements when subjected to a step-change up and a step-change down from setpoint.

(4) All allowable times and cycles shown reference the step-change in setpoint.

Controlled Variable	Change in Setpoint	80% of Step-Change in Setpoint			100% of Step-Change in Setpoint		
		Time (min)	Error	Cycles of Error	Time (min)	Error	Cycles of Error
Duct Temperature	5°F	3	--	--	8	1°F	3
Space Temperature	2°F	2	--	--	5	0.5°F	2
Duct Relative Humidity	5% RH	3	--	B	8	1% RH	3
Space Relative Humidity	5% RH	3	--	B	8	1% RH	3
Duct Static Pressure (variable speed drives)	0.25" w.c.	1	--	--	3	0.05" w.c.	3
Building Static Pressure	to be determined in the field						
Air Flow	to be determined in the field						

(5) When control loop responses cannot be met due to limitations of controlled equipment, provide documentation substantiating such limitations.

Example: Discharge air temperature cannot meet cooling setpoint within the above response times even though the cooling coil valve is fully open. Insufficient online chiller capacity, pumping, coil capacity, etc.

c. Long-Term Response:

(1) Once the controlled variable has attained setpoint, it shall maintain setpoint within the following:

(a) Duct temperature ±0.25°F
(b) Space temperature ±0.25°F
(c) Duct relative humidity ±1.0% RH
(d) Space relative humidity ±1.0% RH
(e) Duct static pressure ±0.05" w.c.

(f) Building static pressure ±0.02″ w.c.
(g) Air flow to be determined in the field

3. All control loops shall be capable of driving their respective actuator full stroke in less than one (1) minute.

D. Equipment Cycling Protection. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

E. Heavy Equipment Delays. The Controller shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

F. Power Fail Motor Restart. Upon the resumption of normal power, the Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

G. Energy Management Applications. Controller shall have the ability to perform all of the following energy management routines, whether utilized or not.

1. All Controllers

a. Time of Day Scheduling
b. Calendar Based Scheduling
c. Holiday Scheduling
d. Temporary Schedule Overrides
e. Night Setback Control
f. Fan Speed/CFM Control
g. Heating/Cooling Interlock

2. All Controllers except Terminal Equipment ASC Controllers

a. Optimal Start and Stop (coordinated with Time of Day Scheduling)
b. Economizer (Dry Bulb and Enthalpy)
c. Peak Demand Limiting
d. Temperature Compensated Load Rolling
e. Air Temperature Reset
f. Water Temperature Reset
g. Chiller Sequencing

3. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment where described on the Drawings.

H. Custom Process Programming Capability. Controllers shall be able to execute custom, job specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs, Variables and Outputs:

It shall be possible to use any of the following in a custom process:

a. Any system-measured point data or status (inputs)
b. Any calculated data (variables)
c. Any results from other processes (outputs)
d. User-defined Constants (variables)
e. Arithmetic functions (+, -, *, /, square root, exp, etc.)
f. Boolean logic operators (and, or, exclusive or, etc.)

g. On-delay/Off-delay/One-shot timers (outputs)

2. Process Triggers

Custom processes may be triggered based on any combination of the following:

a. Time interval
b. Time of day
c. Date
d. Other processes
e. Time programming
f. Events (e.g., point alarms)

3. Dynamic Data Access

A process shall be able to incorporate process input, variable and output data from any and all other Controllers on the network.

In addition, a process shall be able to issue commands to points in any and all other Controllers on the network.

4. Advisory/Message Generation

Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

5. Custom Process Documentation

The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphical flowcharts and English language descriptors.

I. Alarm Management. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the Controller's ability to report alarms be affected by either operator activity at an Operator Workstation, local I/O device, or communications with other Controllers on the network.

1. Point Change Report Descriptions: All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms.

a. A minimum of three priority levels shall be provided.
b. Each Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up.
c. Point priority levels shall be combined with user definable destination categories (i.e., Operator Workstation, printer, Controller, pager, etc.) to provide full flexibility in defining the handling of system alarms.
d. Users shall have the ability to manually inhibit alarm reporting for each point.

e. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

3. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of Operator Workstations used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
4. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store an alarm message to more fully describe the alarm condition or direct operator response.
5. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full.
6. Local Alarms: The Controller shall provide alarms for all analog input values that are outside of user definable ranges, for all binary output points that do not prove status based on a paired binary input status point, and for all programmed binary alarm status points.
   a. The user shall be able, from the Operator Workstation, to configure the alarm limit ranges, limit deadbands and to enable/disable the alarm.
   b. The user shall be able to configure any Controller alarm as a conditional alarm that will only occur when a selected binary point is on or off. This shall be used to prevent nuisance alarms during non-operating and/or Controller start-up modes.
   c. Analog input alarms shall be operator configured to alarm based on:
      (1) An operator adjustable alarm deadband which shall generate a warning or alarm whenever the value is above/below the current active setpoint plus/minus the alarm deadband.
      (2) High and low alarm limit setpoints and return to normal values or deadbands.

J. Historical Data and Trend Analysis. A variety of historical data collection utilities shall be provided to manually and automatically sample, store, and display system data in all of the following ways.

1. Continuous Point Histories: DDC Controllers shall store Point History Files for all analog and binary inputs and outputs and calculated variables ("virtual" points) for their own points and for all ASC Controller points attached to the DDC Controller.
   a. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day.
   b. Point History Files for binary input, binary output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

2. Control Loop Performance Trends: DDC Controllers shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one second increments for verification of control loop performance.
3. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of one minute to two hours, in one minute intervals, shall be provided. Each DDC Controller shall have a dedicated buffer for trend data.
4. Data Storage and Archiving: Trend data shall be stored at the DDC Controller and uploaded to hard disk storage at the Operator Workstation when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in third party personal computer applications.
5. Historical data and trend data shall be provided in formatted reports. User shall be able to define multiple groupings of trend data, each with a unique name. Points may be assigned to multiple groups, each with different collection parameters.
6. Provide commands to view and print reports utilizing the user's defined unique name given to each.

K. Run Time Totalization. DDC Controllers shall automatically accumulate and store run time hours for binary input and output points when specified in the Execution portion of this specification.

1. The user shall have the ability to define a warning limit for Run Time Totalization. Unique, user-specified messages shall be generated when the limit is reached.

L. Analog/Pulse Totalization. DDC Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points when specified in the Execution portion of this specification.

1. Totalization shall provide calculation and storage of accumulations of data such as kWH, gallons, kBtu, ton-hours, etc.
2. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

M. Event Totalization. DDC Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event Totalization shall be performed on a daily, weekly, or monthly basis as programmed when specified in the Execution portion of this specification.

1. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

N. Communications. Provide all software programs to support communications between Controllers, local operator interface(s) and Operator Workstation. Provide software programs for automatic dial-in from a remote terminal to the control system and automatic dial-out from the control system to a remote terminal.

O. Daylight Savings Time. Provide program which will automatically update each Controller's system clock for daylight savings time and revert Controller's system clock to standard time.

P. Hardware/Software Trouble. The Controllers will self-test and monitor their hardware and software for system trouble. Upon detection of any trouble condition an alarm will be initiated at the Controller and at the Operator Interface Workstation. Failure of any unit on the system shall not affect the proper operation of the remaining system components.

Q. Field Point Trouble. The Controllers will analyze field inputs and outputs to monitor for field trouble. Upon detection of any trouble condition it will register an alarm. All alarms will be immediately forwarded to the Operator Workstation. All alarms shall be stored in memory at the DDC Controller.

1. Each analog input point shall be assigned maximum and minimum operating (or expected) values. When the sensed variable exceeds the assigned operating range or is open or shorted, an alarm shall be generated.

2.2 OPERATOR WORKSTATION SOFTWARE DESCRIPTION

A. General

1. Contractor shall furnish and install the latest version of Microsoft Office, which includes Microsoft Word and Excel, that is compatible with the building automation system on each workstation. Turn over the Microsoft Office installation disks for each workstation to the Owner as part of the turnover package.
2. Contractor shall provide all programming of the Operator Workstation related to the installation for controlling, monitoring and alarming the points associated with project. Also, programming shall be provided to store data, retrieve data, generate reports, communicate with all Controllers in the system to accomplish control, monitoring and alarming at the Operator Workstation, downloading of control programs of all connected input/output points to Controllers and to retrieve (upload) control programs from Controllers.
3. Operator interface programs will be menu driven and user prompting in "Windows" programming environment.
4. Contractor shall enter all parameters in software to provide a functional Operator Workstation as specified.
5. The Contractor shall provide start-up and testing of the programming. All specified programming shall perform to the satisfaction of Owner.
6. All programming provided by the Contractor shall be stored on the Operator Workstation hard disk memory and backed-up on tape storage memory by the Contractor.
7. Owner shall aid Contractor with information as required for programming and as specified in this section.

B. Command Entry/Menu Selection Process. Operator Workstation software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software.

C. Password Protection. Operator access to the system shall be under password and personal ID control. Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all Controllers on the network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for Controllers individually.

D. Operator Access. A minimum of five levels of access shall be supported:

1. Level 1 = Data Access and Display
2. Level 2 = Level 1 + Operator Overrides
3. Level 3 = Level 2 + Database Modification
4. Level 4 = Level 3 + Database Generation
5. Level 5 = Level 4 + Password Add/Modification

E. Automatic Log-Off. User definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices online.

F. Point Definitions

1. Each point in the system accessed by the monitoring/alarm Operator Workstation being either a hardware or software point, shall have a short logical name of six to twelve characters and shall have a long descriptive name of 25 to 50 characters.
2. Point definition information programmed by the Contractor shall include but not be limited to:
   a. Logical name
   b. Descriptive name
   c. DDC panel address where it resides
   d. Engineering units
   e. Sensing range
   f. Alarm limits
   g. Normal state/off normal state
   h. Control calibration values
   i. Point function type
3. Point logical names shall be automatically grouped when defining point names.
4. Owner will assist Contractor in developing point definitions where required.

G. Summaries

1. Programming to format summaries shall be provided by the Contractor for implementing user defined logs. The following are summaries that shall be created.
   a. All points
   b. Points by defined groups
   c. Alarms
   d. Alarm limits
   e. Time schedules
   f. Alarm messages
   g. Setpoints

H. Groups

1. Programming shall be created to provide the following point groups:
   a. Air Handling Unit
   b. Terminal Units
   c. Space Temperatures
   d. Miscellaneous controlled/monitored/alarmed devices

2. Include outside air temperature and humidity in each AHU, heating and chiller system point group.

I. Logs – Trend and Alarm

1. Programming to format logs shall be provided by the Contractor for implementing user defined logs. The following are logs that shall be created:
   a. Analog trend
   b. Binary trend
   c. Alarms
2. Each trend log shall have user defined parameters to include:
   a. Scheduled start/stop times
   b. Sample time interval
   c. Number of samples
   d. Name of sampled point
   e. Type of samples required
   f. Engineering unit of samples
3. At minimum, the last sixty (60) values for all input and output points per Controller. Start time of trends shall be operator programmable.
   a. Initially set up trend logs to record the inputs as defined in this section.
   b. Initially time intervals shall be set at two (2) minutes, but shall be user changeable from (1) minute to one (1) hour.
4. The Operator will have the ability for each log to be automatically printed on time schedule or stored in memory, such that the print command can be manually executed.
5. Trend logs shall be capable of being exported to Microsoft Excel, which resides on the Operator Workstation.

J. Data Records

1. Programming to create, store and edit user defined data records shall be provided by the Contractor for implementing the following data records.
   a. Summaries
   b. Logs
   c. Reports
   d. Alarm lists
   e. Alarm messages
   f. System operation information
   g. Operator information

K. Alarms

1. Programming to define specified points as alarm points shall be provided by the Contractor for implementing alarm receiving, reporting and printing.
2. All alarm messages shall be created and programmed by the Contractor for implementing in the event of alarm reporting.
3. Alarm reporting priorities shall be programmed by the Contractor as defined by Owner.
4. All incoming Controller alarms into Operator Workstation shall be programmed for alarm printer, screen and hard disk destinations.

5. Programming shall be created to provide alarms as defined in this section. Provide multiple alarms for multiple systems.

L. Color Graphics

1. Programming to create and store color graphic diagrams shall be provided by the Contractor as specified at the Operator Workstation.
2. All point values included in the color graphic diagrams shall be dynamic when the finished graphic is viewed, monitored, printed and reprogrammed.
3. Color graphic diagrams shall be stored in hard disk memory.
4. The Contractor shall create, program and store the color graphic diagrams.
5. Air Handling Unit Schematics – Show all double line ductwork, fans, dampers, coils, valves, filters, sensors and switches that apply to each system.
6. Binary status and alarm devices included in the color graphic diagrams shall change color when indicating an on or off, high or low, or normal or alarm condition.
7. All point names of devices shown on the color graphic diagrams shall be shown next to their respective device.

PART 3 - EXECUTION

3.1 DDC SYSTEM POINT LISTS

A. For each building system being monitored or controlled, provide input/out points. Refer to Division 23 Section 23 0901, "Temperature Control Hardware," for required spare capacity.

B. Variable Air Volume Box:

VAV - SYSTEM POINTS LIST																
CONTROLLER: COMM 4 VAV	**POINT TYPE**								**ALARMS**							
SYSTEM POINT DESCRIPTION	**GRAPHIC**	**HARDWARE INPUT**	**HARDWARE OUTPUT**	**SOFTWARE POINT**	**HARDWIRE INTERLOCK**	**WIRELESS**	**NETWORK**	**DEFAULT VALUE**	**HIGH ANALOG LIMIT**	**LOW ANALOG LIMIT**	**BINARY**	**LATCH DIAGNOSTIC**	**SENSOR FAIL**	**COMMUNICATION FAIL**	**DIAGNOSTICS**	**NOTES:**
DISCHARGE AIR TEMPERATURE	X	AI							X	X			X			
SPACE TEMPERATURE LOCAL	X	AI							X	X			X			
VAV AIRFLOW	X	AI														
HEAT OUTPUT 1	X		BO													
HEAT OUTPUT 2	X		BO													
HEAT OUTPUT 3	X		BO													
AIR VALVE DRIVE COMMAND	X		FLTG													

OCCUPIED COOLING SETPOINT	X			X				74.0 deg. F	X	X						
OCCUPIED HEATING SETPOINT	X			X				71.0 deg. F	X	X						
OCCUPIED STANDBY COOLING SETPOINT				X				78.0 deg. F	X	X						
OCCUPIED STANDBY HEATING SETPOINT				X				67.0 deg. F	X	X						
UNOCCUPIED COOLING SETPOINT				X				85.0 deg. F								
UNOCCUPIED HEATING SETPOINT				X				60.0 deg. F								
MINIMUM COOLING AIRFLOW SETPOINT				X												NOTE 1
MAXIMUM COOLING AIRFLOW SETPOINT				X												NOTE 1
MINIMUM HEATING AIRFLOW SETPOINT				X												NOTE 1
MAXIMUM HEATING AIRFLOW SETPOINT				X												NOTE 1
OCCUPIED BYPASS TIMER				X												
BAS COMMUNICATION STATE				X				2 HRS						X		NOTE 2
CONTROLLER SPARE HARDWARE POINTS																
BINARY INPUT(S)		1														

GENERAL NOTES	
	1. SEE VAV SCHEDULE FOR VALUES
	2. DISPLAYED AT THE BAS USER INTERFACE IF PRESENT

C. Electric Reheat

ELECTRIC REHEAT COILS - SYSTEM POINTS LIST

CONTROLLER:	POINT TYPE								ALARMS							
SYSTEM POINT DESCRIPTION	GRAPHIC	HARDWARE INPUT	HARDWARE OUTPUT	SOFTWARE POINT	HARDWIRE INTERLOCK	WIRELESS	NETWORK	DEFAULT VALUE	HIGH ANALOG LIMIT	LOW ANALOG LIMIT	BINARY	LATCH DIAGNOSTIC	SENSOR FAIL	COMMUNICATION FAIL	DIAGNOSTICS	NOTES:
DISCHARGE AIR TEMPERATURE	X	AI							X	X			X			
SPACE TEMPERATURE LOCAL	X	AI							X	X			X			
HEAT OUTPUT 1	X		BO													
HEAT OUTPUT 2	X		BO													
HEAT OUTPUT 3	X		BO													
OCCUPIED COOLING SETPOINT	X			X				74.0 deg. F	X	X						
OCCUPIED HEATING SETPOINT	X			X				71.0 deg. F	X	X						
OCCUPIED STANDBY COOLING SETPOINT				X				78.0 deg. F	X	X						
OCCUPIED STANDBY HEATING SETPOINT				X				67.0 deg. F	X	X						
UNOCCUPIED COOLING SETPOINT				X				85.0 deg. F								
UNOCCUPIED HEATING SETPOINT				X				60.0 deg. F								
BAS COMMUNICATION STATE				X				2 HRS						X		
CONTROLLER SPARE HARDWARE POINTS																
BINARY INPUT(S)																

D. Constant Volume RTU

RTU-2 CV RTU - SYSTEM POINT LIST

CONTROLLER: RELIATEL / BCI-R		POINT TYPE					ALARMS							
SYSTEM POINT DESCRIPTION		GRAPHIC	HARDWARE INPUT	HARDWARE OUTPUT	SOFTWARE POINT	DEFAULT VALUE	HIGH ANALOG LIMIT	LOW ANALOG LIMIT	BINARY	LATCH DIAGNOSTIC	SENSOR FAIL	COMMUNICATION FAIL	DIAGNOSTICS	NOTES:
VOYAGER / PRECEDENT *DX Cooling, Gas Heat, Dry Bulb Economizer, Barometric Exhaust*														
SPACE SENSOR	SPACE TEMPERATURE (THERM)		AI		X		X	X			X		DIAGNOSTIC ALARM STATUS	NOTE 2, 3
OUTDOOR AIR TEMPERATURE		X			X						X		DIAGNOSTIC ALARM STATUS	NOTE 2, 3
SUPPLY AIR TEMPERATURE		X	AI		X		X	X			X		DIAGNOSTIC ALARM STATUS	NOTE 3
ECONOMIZER DAMPER POSITION		X	AI		X									NOTE 3
DIRTY FILTER		X	BI		X								DIAGNOSTIC ALARM STATUS	
SUPPLY FAN STATUS		X	BI							X			DIAGNOSTIC ALARM STATUS	
HIGH PRESSURE COMPRESSOR PROTECTION			BI							X			DIAGNOSTIC ALARM STATUS	
LOW PRESSURE COMPRESSOR PROTECTION			BI							X			DIAGNOSTIC ALARM STATUS	
EMERGENCY STOP			BI										DIAGNOSTIC ALARM STATUS	
ECONOMIZER DAMPER OUTPUT		X		AO	X								DIAGNOSTIC ALARM STATUS	NOTE 3
SUPPLY FAN START/STOP		X		BO										
COMPRESSOR 1 START/STOP		X		BO										
COMPRESSOR 2 START/STOP		X		BO										

CONDENSER FAN A START/STOP			BO										
CONDENSER FAN B START/STOP			BO										
GAS VALVE	X		BO						X			DIAGNOSTIC ALARM STATUS	
OCCUPANCY				X									NOTE 2
OCCUPIED COOL SETPOINT				X	74.0 F								NOTE 2
OCCUPIED HEAT SETPOINT				X	71.0 F								NOTE 2
OCCUPIED STANDBY COOL SETPOINT				X	78.0 F								NOTE 2
OCCUPIED STANDBY HEAT SETPOINT				X	67.0 F								NOTE 2
UNOCCUPIED COOL SETPOINT				X	85.0 F								NOTE 2
UNOCCUPIED HEAT SETPOINT				X	60.0 F								NOTE 2
SETPOINT OFFSET				X									NOTE 2
OCCUPIED BYPASS TIMER				X	120 MIN								NOTE 2
COMPRESSOR ENABLE				X	AUTO								NOTE 2
ECONOMIZER ENABLE				X	AUTO								NOTE 2
HEAT / COOL MODE				X	AUTO								NOTE 2
FAN MODE COMMAND				X	ON								NOTE 2
APPLICATION MODE				X	AUTO								NOTE 2
OUTSIDE AIR DAMPER MINIMUM POSITION				X	10.00 %								NOTE 2
EFFECTIVE OCCUPANCY	X			X									NOTE 3
EFFECTIVE HEAT / COOL MODE	X			X									NOTE 3
EFFECTIVE SPACE TEMPERATURE	X			X									NOTE 3
EFFECTIVE SPACE SETPOINT	X			X									NOTE 3
LOCAL SETPOINT				X									NOTE 3
HEAT OUTPUT	X			X									NOTE 3
COOL OUTPUT	X			X									NOTE 3
ALARM	X			X									NOTE 3
COMMUNICATION STATE				X							X		

GENERAL NOTES:

1. NOT USED
2. SNVT NETWORK INPUT VARIABLE
3. SNVT NETWORK OUTPUT VARIABLE

E. Variable Volume RTU

RTU-1 VAV RTU - SYSTEM POINTS LIST														
CONTROLLER: ReliaTel	**POINT TYPE**						**ALARMS**							
SYSTEM POINT DESCRIPTION	**GRAPHIC**	**HARDWARE INPUT**	**HARDWARE OUTPUT**	**SOFTWARE POINT**	**HARDWIRE INTERLOCK**	**DEFAULT VALUE**	**HIGH ANALOG LIMIT**	**LOW ANALOG LIMIT**	**BINARY**	**LATCH DIAGNOSTIC**	**SENSOR FAIL**	**COMMUNICATION FAIL**	**DIAGNOSTICS**	**NOTES:**
DISCHARGE AIR TEMPERATURE LOCAL	X	AI					X	X			X			
OUTSIDE AIR TEMPERATURE LOCAL	X			X			X	X			X			NOTE 1,2
SUPPLY DUCT STATIC PRESSURE LOCAL	X	AI					X	X			X			
PRIMARY FILTER STATUS LOCAL OPEN	X	BI							X					
SUPPLY FAN STATUS LOCAL OPEN	X	BI							X	X				
MIXED AIR DAMPER	X		AO											
SUPPLY FAN SPEED	X		AO											
COOLING OUTPUT 1	X		BO											
COOLING OUTPUT 2	X		BO											
HEATING OUTPUT 1	X		BO											
HEATING OUTPUT 2	X		BO											
OCCUPANCY				X										NOTE 1
OCCUPIED COOLING SETPOINT				X		74.0 deg. F								NOTE 1
OCCUPIED HEATING SETPOINT				X		70.0 deg. F								NOTE 1

OCCUPIED STANDBY COOLING SETPOINT				X		80.0 deg. F								NOTE 1
OCCUPIED STANDBY HEATING SETPOINT				X		65.0 deg. F								NOTE 1
UNOCCUPIED COOLING SETPOINT				X		85.0 deg. F								NOTE 1
UNOCCUPIED HEATING SETPOINT				X		60.0 deg. F								NOTE 1
OCCUPIED BYPASS TIMER				X		2.0 HRS								NOTE 1
ECONOMIZER MINIMUM POSITION				X										
HEATING MODE SETPOINT				X										
COOLING MODE SETPOINT				X										
SUPPLY AIR PRESSURE SETPOINT	X			X										
SETPOINT OFFSET				X										NOTE 1
COMPRESSOR ENABLE				X		AUTO								NOTE 1
HEAT / COOL MODE				X		COOL								NOTE 1
FAN MODE COMMAND				X		ON								NOTE 1
APPLICATION MODE				X		AUTO								NOTE 1
OUTSIDE AIR DAMPER MINIMUM POSITION				X		10%								NOTE 1
EFFECTIVE OCCUPANCY	X			X										NOTE 2
EFFECTIVE HEAT / COOL MODE	X			X										NOTE 2
EFFECTIVE SPACE TEMPERATURE	X			X										NOTE 2
EFFECTIVE SPACE SETPOINT				X										NOTE 2
LOCAL SETPOINT				X										NOTE 2
HEAT OUTPUT	X			X										NOTE 2
COOL OUTPUT	X			X										NOTE 2
ALARM	X			X										NOTE 2
SUPPLY AIR HEATING/COOLING SETPOINT	X			X										
MAINTENANCE REQUIRED				X		600 HRS								
BAS COMMUNICATION STATE	X			X										

GENERAL NOTES	
	1. SVNT NETWORK INPUT VARIABLE
	2. SVNT NETWORK OUTPUT VARIABLE

F. Makeup Air Unit

Hardware Points	**Software Points**

Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Zone Temp	x								x		x
Zone Setpoint Adjust	x										x
Discharge Air Temp	x								x		x
Zone Override			x						x		x
Outside Air Damper Status			x						x		x
Supply Fan Status			x						x		x
Exhaust Fan Status			x						x		x
Outside Air Damper Position		x							x		x
Supply Fan Start/Stop				x					x		x
Exhaust Fan Start/Stop				x					x		x
Heating Stage 1				x					x		x
Heating Stage 2				x					x		x
Wall Ventilation Damper				x					x		x
CO Level (2)	x								x	x	x
NO Level (2)	x								x	x	x
Schedule								x			
Heating Setpoint									x		x
Cooling Setpoint									x		x
High Zone Temp										x	
Low Zone Temp										x	
Outside Air Damper Failure										x	
Outside Air Damper in Hand										x	
Supply Fan Failure										x	
Supply Fan in Hand										x	
Supply Fan Runtime Exceeded										x	
Exhaust Fan Failure										x	
Exhaust Fan in Hand										x	
Exhaust Fan Runtime Exceeded										x	
High Discharge Air Temp										x	
Low Discharge Air Temp										x	
High Zone CO Concentration										x	

	Hardware Points				Software Points						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
High Zone NO_2 Concentration										x	
Totals	**5**	**1**	**4**	**4**	**0**	**0**	**0**	**1**	**15**	**16**	**16**

Total Hardware (14) **Total Software (32)**

3.2 ALARM LIST

A. Set up alarm programming for the system point conditions and events. Provide individual alarms for multiple systems, if appropriate.

3.3 TREND LOG LIST

A. Set up trend logs to record appropriate values for the following systems. Provide individual trends for multiple systems.

1. Air Handling Unit
2. Terminal Units
3. Miscellaneous controlled/monitored/alarmed devices

3.4 TOTALIZATION LIST

A. Runtime Totalization

1. Air handling unit fans

B. Analog Totalization. Provide hourly, daily and monthly totalization calculations.

1. Refrigeration energy (based on current transformers)
2. Steam production
3. Electrical energy consumption
4. Natural gas consumption
5. Water consumption

C. Event Totalization

1. Air handling unit fans

3.5 COLOR GRAPHICS

A. Provide the following project specific color graphic screens:

1. Air Handling Unit Schematics
2. Terminal Units
3. Menus
4. Setpoints
5. Logs
   a. Alarm
   b. Trend
   c. Totalization
6. Building Floor Plans

a. "Hot keys" for each above system
b. Include space sensors
c. Floor plans, in AutoCAD format, will be made available to the Contractor.
d. Contractor shall develop floor plans. PDF copies of floor plans will be made available by the Owner for Contractor's use.

3.6 CONTROL SEQUENCES

A. Provide all hardware and software as required.

B. All existing safeties shall be maintained.

C. Provide end switch on outside air damper of 100% outside air units. Fan shall energize when switch makes contact.

D. Outside air dampers shall close where fans are de-energized.

E. Interlock return fans, if applicable.

F. Provide dead band in all sequenced controls to avoid simultaneous heating and cooling.

G. Provide start/stop of all systems with appropriate safeties.

H. Provide initial time schedules and setpoints of all equipment. Obtain schedules from Owner. All schedules and setpoints shall be operator adjustable and not coded within the software.

3.7 VARIABLE AIR VOLUME BOX.

A. Building Automation System Interface:
The Building Automation System (BAS) shall send the controller Occupied and Unoccupied commands. The BAS may also send a Heat/Cool mode, priority shutdown commands, space temperature and/or space temperature setpoint. If communication is lost with the BAS, the VAV controller shall operate using its local setpoints.

B. Occupancy Mode:
The occupancy mode shall be communicated to the VAV. Valid Occupancy modes for the VAV shall be:
1. Occupied:
Normal operating mode for occupied spaces or daytime operation. When the unit is in the occupied mode the VAV shall maintain the space temperature at the active occupied heating or cooling setpoint. Applicable ventilation and airflow setpoints shall be enforced. The occupied mode shall be the default mode of the VAV.
2. Unoccupied:
Normal operating mode for unoccupied spaces or nighttime operation. When the unit is in unoccupied mode the VAV controller shall maintain the space temperature at the stored unoccupied heating or cooling setpoint regardless of the presence of a hardwired or communicated setpoint. When the space temperature exceeds the active unoccupied setpoint the VAV shall modulate fully closed.

C. Heat/Cool Mode:
The Heat/Cool mode shall be set by a communicated value or automatically by the VAV. In standalone or auto mode the VAV shall compare the primary air temperature with the configured auto changeover setpoint to determine if the air is "hot" or "cold". Heating mode shall command the VAV to heat only; it implies the primary air temperature is hot. Cooling mode shall command the VAV to cool only; it implies the primary air temperature is cold.

D. Heat/Cool Setpoint:
The space temperature setpoint shall be determined either by a local (e.g., thumbwheel) setpoint, the VAV default setpoint or a communicated value. The VAV shall use the locally stored default setpoints when neither a local setpoint nor communicated setpoint is present. If both a local setpoint and communicated setpoint exist, the VAV shall use the communicated value.

E. Cooling Mode:
When the unit is in cooling mode, the VAV controller shall maintain the space temperature at the active cooling setpoint by modulating the airflow between the active cooling minimum airflow setpoint to the maximum cooling airflow setpoint. Based on the VAV controller occupancy mode, the active cooling setpoint shall be one of the following:

1.

Setpoint	**Default Value**
Occupied Cooling Setpoint	74.0 deg. F
Unoccupied Cooling Setpoint	85.0 deg. F
Occupied Standby Cooling Setpoint	78.0 deg. F
Occupied Min Cooling Airflow Setpoint	See VAV Schedule
Occupied Max Cooling Airflow Setpoint	See VAV Schedule

The VAV shall use the measured space temperature and the active cooling setpoint to determine the requested cooling capacity of the unit. The outputs will be controlled based on the unit configuration and the requested cooling capacity.

F. Heating Mode:
When the unit is in heating mode, the VAV controller shall maintain the space temperature at the active heating setpoint by modulating the airflow between the active heating minimum airflow setpoint to the maximum heating airflow setpoint. Based on the VAV controller occupancy mode, the active heating setpoint shall be one of the following:

1.

Setpoint	**Default Value**
Occupied Heating Setpoint	71.0 deg. F
Unoccupied Heating Setpoint	60.0 deg. F
Occupied Standby Heating Setpoint	67.0 deg. F
Occupied Min Heating Airflow Setpoint	See VAV Schedule
Occupied Max Heating Airflow Setpoint	See VAV Schedule

The VAV controller shall use the measured space temperature and the active heating setpoint to determine the requested heating capacity of the unit. The outputs will be controlled based on the unit configuration and the requested heating capacity.

G. Reheat Control:
Reheat will only be allowed when the primary air temperature is 5.0 deg. F below the configured reheat enable setpoint of 70.0 deg. F (adj.). The reheat shall be enabled when the space temperature drops below the active heating setpoint and the minimum airflow

requirements are met. During reheat the VAV shall operate at its minimum heating airflow setpoint and energize the heat as follows:

H. Electric Staged:
1. Stage 1 is energized when the space temperature falls below the active heating setpoint and minimum airflow requirements are met. When the zone temperature rises above the active heating setpoint by 0.5 deg. F, stage 1 is de-energized.
2. Stage 2 energizes when the space temperature is 1.0 deg. F or more below the active heating setpoint, and is de-energized when the space temperature is 0.5 deg. F below the active heating setpoint.
3. Stage 3 energizes when the zone temperature is 2.0 deg. F or more below the active heating setpoint, and de-energizes when the space temperature is 1.5 deg. F below the active heating setpoint.

I. Space Sensor Failure:

1. If there is a fault with the operation of the zone sensor an alarm shall be annunciated at the BAS. Space sensor failure shall cause the VAV to drive the damper to minimum air flow if the VAV is in the occupied mode, or drive it closed if the VAV is in the unoccupied mode.

L. Constant Volume RTU

1. Building Automation System Interface:

   The Building Automation System (BAS) shall send the controller Occupied Bypass, Morning Warm-up / Pre-Cool, Occupied / Unoccupied and Heat / Cool modes. If a BAS is not present, or communication is lost with the BAS the controller shall operate using default modes and setpoints.

2. Occupied Mode:

   During occupied periods, the supply fan shall run continuously and the outside air damper shall open to maintain minimum ventilation requirements. The DX cooling and gas heat shall stage to maintain the occupied space temperature setpoint. If economizing is enabled the outside air damper shall modulate to maintain the occupied space temperature setpoint. Unit shall be occupied 24/7.

3. Unoccupied Mode:

   When the space temperature is below the unoccupied heating setpoint of 60.0 deg. F (adj.) the supply fan shall start, the outside air damper shall remain closed and the gas heat shall be enabled. When the space temperature rises above the unoccupied heating setpoint of 60.0 deg. F (adj.) plus the unoccupied differential of 4.0 deg. F (adj.) the supply fan shall stop and the gas heat shall be disabled.

   When the space temperature is above the unoccupied cooling setpoint of 85.0 deg. F (adj.) the supply fan shall start, the outside air damper shall open if economizing is enabled and remain closed if economizing is disabled and the DX cooling shall be enabled. When the space temperature falls below the unoccupied cooling setpoint of 85.0 deg. F (adj.) minus the unoccupied differential of 4.0 deg. F (adj.) the supply fan shall stop, the DX cooling shall be disabled and the outside air damper shall close.

4. Optimal Start:

The BAS shall monitor the scheduled occupied time, occupied space setpoints and space temperature to calculate when the optimal start occurs.

5. Morning Warm-Up Mode:

   During optimal start, if the space temperature is below the occupied heating setpoint a morning warm-up mode shall be activated. When morning warm-up is initiated the unit shall enable the heating and supply fan. The outside air damper shall remain closed. When the space temperature reaches the occupied heating setpoint (adj.), the unit shall transition to the occupied mode.

6. Pre-Cool Mode:

   During optimal start, if the space temperature is above the occupied cooling setpoint, pre-cool mode shall be activated. When pre-cool is initiated the unit shall enable the fan and cooling or economizer. The outside air damper shall remain closed, unless economizing. When the space temperature reaches occupied cooling setpoint (adj.), the unit shall transition to the occupied mode.

7. Optimal Stop:

   The BAS shall monitor the scheduled unoccupied time, occupied setpoints and space temperature to calculate when the optimal stop occurs. When the optimal stop mode is active the unit controller shall maintain the space temperature to the space temperature offset setpoint.

8. Occupied Bypass:

   The BAS shall monitor the status of the "on" and "cancel" buttons of the space temperature sensor. When an occupied bypass request is received from a space sensor, the unit shall transition from its current occupancy mode to occupied bypass mode and the unit shall maintain the space temperature to the occupied setpoints (adj.).

9. Cooling Mode:

   The unit controller shall use space temperature and space temperature setpoint to determine when to initiate requests for cooling. When the space temperature rises above the setpoint, the unit controller shall modulate the economizer or stage the DX cooling as required to maintain the space temperature setpoint. The first compressor shall energize after its minimum 3-minute off time has expired. If additional cooling capacity is required the second stage of cooling shall be enabled. Once the space temperature falls below the setpoint the compressors shall be deactivated and the economizer shall return to minimum position.

10. Heating Mode:

    The unit controller shall use the space temperature and space temperature setpoint to determine when to initiate requests for heat. When the space temperature drops below the setpoint, the unit controller shall enable gas heating stages to maintain the space temperature setpoint. Once the space temperature rises above the setpoint the gas heating stages shall be disabled.

11. Economizer:

    The mixed air sensor shall measures the dry bulb temperature of the air leaving the evaporator coil while economizing. When economizing is enabled and the unit is operating in the cooling mode, the economizer damper shall be

modulated between its minimum position and 100% to maintain the space temperature setpoint. The economizer damper shall modulate toward minimum position in the event the mixed air temperature falls below the low limit temperature setting. Compressors shall be delayed from operating until the economizer has opened to 100%.

12. Reference Dry Bulb:

Outside air (OA) temperature shall compared with a reference dry bulb setpoint. The economizer shall enable when the OA temperature is less than reference dry bulb setpoint. The economizer shall be disabled when OA temperature is greater than reference dry bulb setpoint + 5.0 deg. F.

13. Supply Fan:

The supply fan shall be enabled while in the occupied mode and cycled on during the unoccupied mode. A differential pressure switch shall monitor the differential pressure across the fan. If the switch does not open within 40 seconds after a request for fan operation a fan failure alarm shall be annunciated at the BAS, the unit shall stop, requiring a manual reset.

14. Filter Status:

A differential pressure switch shall monitor the differential pressure across the filter when the fan is running. If the switch closes for 2 minutes after a request for fan operation a dirty filter alarm shall be annunciated at the BAS**.**

3.8 VARIABLE VOLUME RTU

A. Building Automation System Interface:

1. The Building Automation System (BAS) shall send the controller Occupied Bypass, Morning Warm-up / Pre-Cool, Occupied / Unoccupied and Heat / Cool modes. If a BAS is not present, or communication is lost with the BAS the controller shall operate using default modes and setpoints.

B. Occupied Mode:

2. During occupied periods, the supply fan shall run continuously and the outside air damper shall open to maintain minimum ventilation requirements. The unit controller shall control the supply fan speed to maintain the current duct static pressure setpoint (adj.).The DX cooling and gas heat shall stage to maintain the current discharge air temperature setpoint. If economizing is enabled the outside air damper shall modulate to maintain the current discharge air temperature setpoint. Unit shall be occupied 24/7.

C. Unoccupied Mode:

3. When the space temperature is below the unoccupied heating setpoint of 60.0 deg. F (adj.) the supply fan shall modulate as necessary to maintain duct static pressure setpoint (adj.), the outside air damper shall remain closed and the gas heat shall be enabled. When the space temperature rises above the unoccupied heating setpoint of 60.0 deg. F (adj.) plus the unoccupied differential of 4.0 deg. F (adj.) the supply fan shall stop and the gas heat shall be disabled.
4. When the space temperature is above the unoccupied cooling setpoint of 85.0 deg. F (adj.) the supply fan shall modulate as necessary to maintain duct static pressure setpoint (adj.), the outside air damper shall open if economizing is enabled and remain closed if economizing is disabled and the DX cooling shall be enabled. When the space temperature falls below the unoccupied cooling

setpoint of 85.0 deg. F (adj.) minus the unoccupied differential of 4.0 deg. F (adj.) the supply fan shall stop, the DX cooling shall be disabled and the outside air damper shall close.

D. Optimal Start:
   1. The BAS shall monitor the scheduled occupied time, occupied space setpoints and space temperature to calculate when the optimal start occurs.

E. Morning Warm-Up Mode:
   1. During optimal start, if the average space temperature is below the occupied heating setpoint a morning warm-up mode shall be activated. When morning warm-up is initiated the unit shall enable the heating and supply fan. The outside air damper shall remain closed. When the average space temperature reaches the occupied heating setpoint (adj.), the unit shall transition to the occupied mode.

F. Pre-Cool Mode:
   1. During optimal start, if the average space temperature is above the occupied cooling setpoint, pre-cool mode shall be activated. When pre-cool is initiated the unit shall enable the fan and cooling or economizer. The outside air damper shall remain closed, unless economizing. When the average space temperature reaches occupied cooling setpoint (adj.), the unit shall transition to the occupied mode.

G. Optimal Stop:
   1. The BAS shall monitor the scheduled unoccupied time, occupied setpoints and space temperature to calculate when the optimal stop occurs. When the optimal stop mode is active the unit controller shall maintain the space temperature to the space temperature offset setpoint.

H. Occupied Bypass:
   1. The BAS shall monitor the status of the “on” and “cancel” buttons of the space temperature sensors. When an occupied bypass request is received from a space sensor, the unit shall transition from its current occupancy mode to occupied bypass mode and the unit shall maintain the space temperature to the occupied setpoints (adj.).

I. Economizer:
   1. The supply air sensor shall measures the dry bulb temperature of the air leaving the evaporator coil while economizing. When economizing is enabled and the unit is operating in the cooling mode, the economizer damper shall be modulated between its minimum position and 100% to maintain the discharge air temperature setpoint. The economizer damper shall modulate toward minimum position in the event the mixed air temperature falls below the low limit temperature setting. Compressors shall be delayed from operating until the economizer has opened to 100%.
   2. Reference Dry Bulb:
      a. Outside air (OA) temperature shall compared with a reference dry bulb setpoint. The economizer shall enable when the OA temperature is less than reference dry bulb setpoint. The economizer shall be disabled when OA temperature is greater than reference dry bulb setpoint + 5.0 deg. F.

J. Supply Fan:
   1. The supply fan shall be enabled while in the occupied mode and cycled on during the unoccupied mode. A differential pressure switch shall monitor the differential pressure across the fan. If the switch does not open within 40 seconds

after a request for fan operation a fan failure alarm shall be annunciated at the BAS, the unit shall stop, requiring a manual reset.

K. Supply Duct Static Pressure Control:

1. The unit controller shall modulate the supply fan output as required to maintain the duct static pressure setpoint. If the duct static pressure falls below the supply air static setpoint + deadband, the unit controller shall increase the output to the supply fan to maintain setpoint. If the duct static pressure rises above the supply air static setpoint + deadband, the unit controller shall decrease the output to the supply fan to maintain setpoint.

L. Building Pressure Control:

1. The barometric relief dampers shall open with increased building pressure. As the building pressure increases, the pressure in the unit return section also increases, opening the dampers and relieving air.

M. Filter Status:

1. A differential pressure switch shall monitor the differential pressure across the filter when the fan is running. If the switch closes for 2 minutes after a request for fan operation a dirty filter alarm shall be annunciated at the BAS.

3.9 MAKEUP AIR UNIT

A. Run Conditions - Scheduled:

The unit shall run according to an occupancy sensor, gas monitoring ventilation or as srequired by space temperature. in the following modes:

- Occupied Mode: The unit shall maintain
- A 78°F (adj.) cooling/ventilation setpoint
- A 66°F (adj.) heating setpoint.
- Unoccupied Mode (night setback): The unit shall maintain
- A 85°F (adj.) cooling setpoint.
- A 55°F (adj.) heating setpoint.

Alarms shall be provided as follows:

- Low Zone Temp: If the zone temperature is less than the heating setpoint by 10°F (adj.).

B. Zone Unoccupied Override:

1. A local override control shall be received from occupancy sensor (15 minute off delay at sensor) and place the unit into an occupied mode until occupancy sensor time out. At the expiration of this time, control of the unit shall automatically return to the unoccupied mode.

C. Outside Air Damper – Occupied

1. The outside air damper shall open to 30% (adj.) and shall close anytime the unit stops. Damper shall be controllable through the BAS.

D. Outside Air Damper – Unoccupied

1. The outside air damper shall remain closed unless CO and/or NO_2 levels are above acceptable limits (adj.). Damper shall be controllable through the BAS.

E. Outside Air Damper – High CO/NO_2 concentrations

1. The outside air damper shall open to 100% whenever CO and/or NO_2 levels are above acceptable limits (adj.).
   a. Alarms shall be provided as follows:

F. Outside Air Damper Failure: Commanded open, but the status is closed.

G. Outside Air Damper in Hand: Commanded closed, but the status is open.

H. Supply Fan:

1. The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime, unless shutdown on safeties. Fan shall be commanded to run continuously during occupied hours.
2. Alarms shall be provided as follows:
   a. Supply Fan Failure: Commanded on, but the status is off.
   b. Supply Fan in Hand: Commanded off, but the status is on.
   c. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

I. Exhaust Fan:

The exhaust fan shall run whenever CO/NO_2 levels are above the limits set by user, unless shutdown on safeties.

1. Alarms shall be provided as follows:
   a. Exhaust Fan Failure: Commanded on, but the status is off.
   b. Exhaust Fan in Hand: Commanded off, but the status is on.
   c. Exhaust Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

J. Exterior Wall Ventilation Damper:

1. The damper shall open whenever CO/NO_2 levels are above the limits set by user AND outdoor air temperature is greater than 45°F.

K. Gas Heating Stages:

1. The controller shall measure the zone temperature and stage the heating to maintain its heating setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime.
2. The heating shall be enabled whenever:
   a. Outside air temperature is less than 55°F (adj.).
   b. AND the zone temperature is below heating setpoint.
   c. AND the fan status is on.

L. Discharge Air Temperature:

1. The controller shall monitor the discharge air temperature.
2. Alarms shall be provided as follows:
   a. High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
   b. Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).
3. Zone Carbon Monoxide (CO) and Nitrogen Dioxide (NO_2) Concentration Monitoring:
   a. The controller shall measure the zone CO and NO_2 levels.
4. Alarms shall be provided as follows:
   a. High Zone Carbon Monoxide Concentration: If the zone CO concentration is greater than 100ppm (adj.).
   b. High Zone Nitrogen Dioxide Concentration: If the zone NO_2 concentration is greater than 1ppm (adj.).

3.10 CONTROL SYSTEM FAILURES

A. Digital control system failure is defined as loss of controller program, lock-up of controller program, loss of controller power or loss of field interface device power.

1. In the event of digital control system failure, supply fans shall remain in last commanded state (ON or OFF); all modulating dampers and valves shall remain in last commanded state.

END OF SECTION

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SECTION 23 0903
TEMPERATURE CONTROL CONDUIT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit

B. Connectors

C. Junction Boxes

1.2 SCOPE

A. This section includes conduit requirements for use with wire, cable and pneumatic polyethylene tubing.

1.3 SUBMITTALS

Not Applicable

PART 2 - PRODUCTS

2.1 CONDUIT

A. All wiring shall be installed in a complete conduit raceway system of a minimum trade size of ½". Conduit shall be installed continuous from terminal to terminal and shall be mechanically and electrically connected. The entire system shall be grounded.

1. Exception: With permission of Owner, metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors. Receive authorization from Owner before using surface raceway.
2. Exception: The conduit system shall be complete except that up to 12" of exposed Class 2, 3, or communications wiring may be used from the conduit system to an actuator. Wiring extending beyond the conduit system shall be protected by a plastic bushing at the end of the conduit.

B. Conduit installed outside or exposed to moisture shall be rigid aluminum. Conduit in other areas shall be electric metallic tubing (EMT).

C. Conduits installed in dry locations requiring flexible connections for adjustment or vibration isolation shall be provided with a 14" maximum length of flexible galvanized steel (Greenfield) conduit. Flexible conduit installed in wet locations and exterior locations shall be liquid-tight type.

2.2 CONNECTORS

A. Couplings and connectors for use with rigid aluminum shall be the threaded type. Terminations shall be with double locknut and insulated bushings. Fittings installed outdoors shall be water tight.

B. Couplings and connectors for electrical metallic tubing (EMT) shall be gland compression.

2.3 JUNCTION BOXES AND PULL BOXES

A. Provide junction boxes and pull boxes of the proper size and shape.

B. Junction and pull boxes shall be supported independently of the conduit system.

C. Junction and pull boxes shall be of galvanized steel construction.

D. Paint each junction box cover per specification Division 26 Section 26 0505, "Basic Electrical Materials and Methods." Mark cover using permanent marker to indicate that wiring enclosed is associated with the controls system.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION

A. Conduit shall not be smaller than the sizes indicated or specified, and where no size is indicated, the Contractor shall size the conduit in accordance with the requirements of the local/state Electrical Code for the number, size and type of wires indicated and specified for application, except that no conduit shall be less than ½" trade size.

B. Where conduit enters panel boxes, pull boxes, outlet boxes or wireways, it shall be secured in place by galvanized locknut on the outside and galvanized locknut and bushing on the inside. Bushing shall be insulated throat type with ground lug. Care shall be taken to see that all conduit runs from a permanent and continuous ground return back to the panel ground connection point. All bushings shall be bonded to the junction box, outlet box, cabinet, etc. Where required, bonding jumpers shall be installed between conduit and boxes.

C. Conduits for branch circuits shall be installed continuous between connections to outlets, boxes and cabinets and shall have a minimum possible number of bends or fittings. Bends shall be made with an approved hickey or conduit-bending machine and shall be smooth and even without flattening or flaking.

D. Exposed conduit runs shall be run neatly and shall be parallel to the walls of the building.

E. The actual installation of conduit shall be made in the field to clear all piping, ductwork, equipment fixtures, ceiling inserts, access doors, etc. Bends, turns, and pull boxes, as required, shall be provided in accordance with field conditions.

F. Conduit ends shall be reamed and shall be thoroughly cleaned before installation. Conduit openings and boxes shall be plugged or covered as required to keep conduit clean during construction. All conduit shall be swabbed clear of obstructions before the pulling of wires.

G. All threaded joints in rigid aluminum conduit shall be sealed with Thomas & Betts "Alum-Shield" compound on the male thread only.

H. Conduit runs shall be securely fastened in place with approved straps, and hangers and supports from inserts set in the construction above. Vertical conduit shall be securely clamped to steel members and unistruts, and attached to the structure.

I. Conduit shall not pierce or interfere with waterproofing, vapor barriers, damp-proofing, etc.

J. Raceways run through foundation walls, basement slabs, or through any walls for floors that have vapor barriers, waterproofing, or any type of damp-proofing, shall be sealed by use of special wall and floor entrance seals designed for the purpose. Drawings of the proposed seals and clamping arrangements shall be submitted for approval.

K. Conduits passing from the building exterior to interior or passing between conditioned and non-conditioned spaces shall be sealed to prevent condensation in the conduit.

L. Conduits crossing building expansion joints shall be provided with expansion fittings and flexible grounded bonds bypassing the fittings to insure ground continuity.

M. All conduit shall be supported with fasteners designed for the application and must be attached to the building structure and shall not be supported from other conduit, pipes, ductwork, ceiling suspension members or equipment. Existing pipe hangers for multiple conduits with spare capacity may be used.

1. Exception: When conduit is required to terminate at a sensor or control point on ductwork, the conduit may be fastened to the ductwork. This is the only condition in which conduit is allowed to be fastened to ductwork.
2. Note: Perforated metal strap and tie wire are prohibited.

N. Existing conduit which is in place and has additional wire carrying capacity due to existing wiring being removed or due to original spare capacity may be used for new wiring if the conduit installation meets this Temperature Control conduit specification.

O. All openings for conduit passing through masonry walls or floor shall be core drilled by this Contractor. Core holes shall be sealed as follows:

1. For the conduits penetrating floor or fire walls, the Contractor shall provide fire stopping equivalent to the construction penetrated.
2. Where conduit passes through floor or exterior walls, caulk at both sides to insure waterproofing around conduit.
3. Where conduit penetrates walls separating quiet areas such as offices from noisy areas such as equipment rooms, the opening around the conduit shall be filled with fiberglass insulation and sealed.

3.2 JUNCTION BOX INSTALLATION

A. All outlets shall be installed in accessible locations and none shall be installed above ducts, behind furring or in other similar locations. Any outlet designated as providing power for particular piece of equipment shall be accessible for disconnection with said unit in place.

END OF SECTION

SECTION 23 0904
TEMPERATURE CONTROL WIRING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wire

B. Cable

1.2 SCOPE

A. Power wiring, Class 1, 2, or 3 wiring, and communications wiring required for satisfactory installation and operation of all equipment specified under temperature control shall be furnished and installed by this contractor.

B. Wiring shall be installed in accordance to wiring specification found in this section.

C. All wiring shall be UL listed and installed in accordance with applicable electrical codes and shall comply with equipment manufacturer's recommendations.

Note: When specified materials or installation methods exceed applicable electrical codes and equipment manufacturer's recommendations, this specification shall govern.

1.3 SUBMITTALS

A. Submit data and samples of the following:

1. Analog Cable
2. Other low voltage signal cable

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. All wires shall be copper and shall meet the minimum wire size and insulation class listed.

Wire Class	Minimum Wire Size	Minimum Insulation Class
Power	12 Gauge	600 Volt
Class 1	14 Gauge Stranded	600 Volt
Class 2	18 Gauge Stranded	300 Volt
Class 3	18 Gauge Stranded	300 Volt
Communications	Per Manufacturer	Per Manufacturer

B. 120V power circuit wiring shall be #12 AWG. Home runs longer than 100 feet shall be #10 AWG.

C. 24V control power circuit wiring and all wiring to flow switches and relays shall be #14 AWG. Runs greater than 200 feet in length shall be #12 AWG.

D. Use twisted shielded pair, insulated and jacketed cable, #18 AWG minimum, for wiring to sensors (temperature, humidity, etc.). All sensor wiring shall have a 100% grounded shield.

E. Network communications wiring shall be in accordance with manufacturer's specifications.

F. Use THHN wires for power circuit wiring and all control wiring in dry locations; use THWN wires for wet locations.

G. Conductors shall be continuous from outlet to outlet and no splices or connections shall be made, except within outlet boxes, junction boxes or cabinets.

H. Permanent wiring shall not be pulled into conduits or raceways until permission is granted by Owner.

I. Where the space above a ceiling is a supply or return air plenum, the wiring therein shall be plenum rated.

PART 3 - EXECUTION

3.1 WIRING

A. All sensor wiring shall use crimped or soldered connections; wire nuts are not allowed.

B. Sensor wiring shall be continuous containing no splices between the digital controller and the field sensor.

C. Identify all control/signal wires with labeling tape using either words, letters or numbers that can be exactly cross-referenced with as-built drawings.

3.2 INSTALLATION

A. Wires shall be kept a minimum of 3" from hot water piping, steam piping, condensate piping or any other hot surfaces.

B. The Contractor shall provide a separate insulated green ground wire inside each power branch circuit conduit. Connect one end of the ground wire to the ground bus or ground terminal in the panel board. Connect the other end of the ground wire to the grounding lug in equipment being served. Provide and install a grounding lug in equipment being served if no grounding lug exists.

C. Identify all temperature control raceways with labels stating "Control System Wiring." Typed (not handwritten) labels shall be affixed to the covers of all junction boxes and pull boxes.

3.3 RACEWAY SYSTEM

A. Power and Class 1 wiring may be run in the same conduit. Class 2 and 3 wiring and communications wiring may be run in the same conduit. Power and Class 1 may not be run together with Class 2, Class 3, or communications wiring.

B. No sensor wiring shall be run in the same conduit with power or Class 1 wiring.

C. Where different wiring classes terminate within the same enclosures, maintain clearances and install barriers per National Electric Code.

D. Pneumatic tubing may not be run in wiring conduit.

E. Wiring within air handling units shall be in a complete conduit system.

END OF SECTION

SECTION 23 0906
TEMPERATURE CONTROL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Miscellaneous Existing Controls

B. Demolition of Controls

1.2 SCOPE

A. Demolition of DDC and pneumatic control panels, devices and associated wiring, tubing and conduit for mechanical systems specified in this section.

1.3 SUBMITTALS

Not Applicable

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 MISCELLANEOUS EXISTING CONTROLS

A. Existing control equipment that is to remain is to be calibrated/adjusted for proper operation.

B. Any equipment found to be defective and requiring replacement shall be brought to the attention of Owner. Owner will be responsible for repairs to same.

C. Existing control equipment that is to remain shall be relocated to a new enclosure.

3.2 DEMOLITION

A. Demolition of the existing control systems shall be limited to those systems in which the temperature controls are to be replaced by this Project.

B. Demolition shall include removal of all existing direct digital controls, electric controls and pneumatic controls not specifically identified to remain. This includes but is not limited to:

1. Field control panels
2. Temperature control panels
3. Pneumatic/electric controls associated with mechanical systems equipment
4. Pneumatic tubing
5. Electric devices, wiring and conduit

Note: Abandoned tubing and wiring, including conduit, shall be removed completely except where tubing or conduit are installed in inaccessible locations, such as within walls or floors. All tubing ends shall be capped. Above drop ceilings is considered to be inaccessible except that wiring and pneumatic tubing within or outside conduit is to be pulled out. Conduit is to remain in place.

C. Demolition of temperature control panels includes removal of all associated wiring.

D. Owner will inform the Contractor of any equipment to be removed that will remain the property of Owner. All other equipment removed shall be disposed of by the Contractor.

E. The Contractor shall insure that removed controls do not compromise the operation of the existing controls which remain.

F. The Contractor shall be required to make minor modifications to the existing control system such that when a portion of a control system is removed, the remaining system is left in a neat and orderly condition similar to the original installation.

1. It is the intent of this project to eliminate existing DDC, electric and pneumatic control panels where much of the internal equipment is no longer needed. Consolidate equipment that is to remain into one new field panel.
2. Caution is necessary in this consolidation/clean-up mode, since there is potential for existing wiring which passes through these panels and does not terminate at the panel.
    a. Where control panels, once so demolished of controls, devices, etc., render the remaining function of the panel to be a junction box or pull box, Contractor shall so remove the control panel and install a junction box and necessary conduit, where allowed by code.
    b. Contractor shall maintain all fire and smoke control system interlocks on units where such exists.

G. Patch and seal any holes left in ductwork, walls, etc. after the existing controls have been removed. A stainless or Owner-approved equal cover plate may be used in finished spaces.

H. Temporary work necessary to maintain air flow, space temperature and relative humidity during demolition of existing controls shall be provided by this Contractor.

END OF SECTION

SECTION 23 1113
FUEL GAS PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Pipe and pipe fittings

B. Valves and gas cocks

C. Natural gas piping system

1.2 REFERENCES

A. American National Standards Institute (ANSI)

1. ANSI A21.52 - Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Gas
2. ANSI Z21.69 - Connectors for Movable Gas Appliances

B. American Society of Mechanical Engineers (ASME)

1. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300
2. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV
3. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
4. ASME Sec. 9 - Welding and Brazing Qualifications
5. ASME - Boiler and Pressure Vessel Code

C. American Society for Testing and Materials (ASTM)

1. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
2. ASTM A377-79 - Gray Iron and Ductile Iron Pressure Pipe
3. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
4. ASTM B32 - Solder Metal
5. ASTM B88 - Seamless Copper Water Tube
6. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
7. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
8. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Piping Fittings. Schedule 40.
9. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings
10. ASTM D2517 - Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
11. ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe
12. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

D. American Welding Society (AWS)

1. AWS A5.8 - Brazing Filler Metal
2. AWS D1.1 - Structural Welding Code

E. American Water Works Association (AWWA)

1. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids

2. AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids
3. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings
4. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

F. American Gas Association Laboratories (AGA)

G. Environmental Protection Agency (EPA)

H. Underwriters Laboratories Inc. (UL)

1.3 QUALITY ASSURANCE

A. Pipe: Each length of pipe shall be legibly identified at mill by paint, stenciling or raised symbols identifying manufacturer and class type or schedule of pipe. Copper pipe shall be identified at 3 foot intervals.

B. Fittings: To be identified by the manufacturer by permanently attached tags, imprints or other approved means, indicating the class of wall thickness and material.

C. Valves and Gas Cocks: Manufacturer's name and pressure rating marked on valve body.

D. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

E. Welders Certification: In accordance with ASME Sec 9.

1.4 SUBMITTALS

A. Submit shop drawings and product data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store and protect products under provisions of Division 01.

B. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53, Schedule 40 black. Fittings: ASME B16.3, malleable iron, or ASTM A234, forged steel welding type. Joints: Screwed for pipe 2" and under; AWS D1.1, welded, for pipe over 2".

B. Flexible Gas Hose Connectors: UL listed stainless steel hose and braided cover with carbon steel fittings. Up to 2½" pipe size provide male threaded ends.

2.2 FLANGES, UNIONS AND COUPLINGS

A. Pipe Size 2" and Under: ASME B16.3 150 psig malleable iron unions for threaded ferrous piping; ASME B16.15 bronze unions for copper pipe, soldered joints.

B. Unions Above 150 psig: 300 psig malleable iron, brass to iron seat ground joint air tested unions.

C. Pipe Size Over 2": ASME B16.5 150 psig forged steel slip-on flanges for ferrous piping; ANSI/ASME B16.24 bronze flanges for copper piping; neoprene gaskets for gas service; 1/16" thick preformed neoprene.

D. Flanges to match those on valves and equipment.

E. Flange Bolts: ASTM A-193.

F. Dielectric Connections:

1. Flanged or union type: Gaskets to conform to manufacturer's recommendations for the intended service, rated at minimum temperature of 200F (or higher as dictated by service) for continuous duty.
2. Union type: Galvanized or plated steel-threaded end; copper -- solder end; water impervious isolation barrier.
3. Fittings provided shall meet ANSI B16.8 and be capable of isolating stray electrical currents up to 600 volts minimum.
4. Acceptable Manufacturers: B&K Industries, Inc., Eclipse, Inc., EPCO Sales Inc., Capital Manufacturing Company; Division of Harsco Corporation, Watts Regulator Company.

2.3 ACCEPTABLE MANUFACTURERS - GATE VALVES

A. Crane

B. Hammond

C. Stockham

D. Milwaukee

2.4 GATE VALVES

A. Up to 2": 125 psi SWP, bronze body, union bonnet, bronze trim, rising stem with acme thread and square end, malleable iron, handwheel, inside screw, solid wedge or disc, threaded ends. Model 1152 manufactured by Milwaukee.

B. 2" and greater: 125 psi SWP, iron body, bolted flanged yoke-bonnet, gland packed, bronze trim, rising stem, cast iron, handwheel, OS&Y, solid wedge, flanged ends. Model F-2885-M manufactured by Milwaukee.

2.5 ACCEPTABLE MANUFACTURERS - GLOBE VALVES

A. Crane

B. Hammond

C. Stockham

D. Milwaukee

2.6 GLOBE VALVES

A. Up to 2": 150 psi SWP, bronze body, union bonnet, bronze trim, rising stem with Acme thread and square end and malleable iron handwheel, inside screw, renewable composition BUNA-N or teflon]disc, screwed ends, with backseating capacity. Model 590 manufactured by Milwaukee.]2" and greater: 125 psi SWP, iron body, bolted flanged yoke-bonnet, gland packed, bronze trim, rising stem, cast iron handwheel, OS&Y, solid disc, flanged ends, renewable seat and disc. Model F-2981-M manufactured by Milwaukee.

2.7 ACCEPTABLE MANUFACTURERS - SQUARE HEAD GAS COCKS (UP TO 2")

A. McDonald

B. Walworth

2.8 SQUARE HEAD GAS COCKS (UP TO 2")

A. 125 psi bronze body, square head with check, bronze plug, non-lubricated, threaded ends, with one wrench operator for every ten plug cocks. Fig. 10604 manufactured by McDonald.

2.9 ACCEPTABLE MANUFACTURERS - PLUG GAS COCKS (OVER 2")

A. Walworth

B. Rockwell - Nordstrom

C. DeZurik

2.10 PLUG GAS COCKS (OVER 2")

A. 175 psi, cast iron body, stop collar and plug, pressure lubricated, teflon packing, flanged ends, with wrench operator with set screw. Fig. 1796 manufactured by Walworth.EXECUTION

2.11 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Field test all piping before start-up of equipment.

2.12 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner, plumb and parallel to building and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space and other work.

D. Group piping whenever practical at common elevations. Space piping to permit paint and servicing of valves and cocks.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Division 20 Section 20 0516, "Expansion Compensation for Mechanical, Plumbing, and Fire Protection."

F. Provide clearance for access to valves and fittings.

G. Provide access where valves or cocks and fittings are not exposed.

H. Provide sleeves when penetrating floors and walls. Refer to Division 20 Section 20 0517, "Penetrations for Mechanical, Plumbing, and Fire Suppression Systems."

I. Seal pipe and sleeve penetration to achieve fire resistance equivalent to fire separation required. Refer to Division 20 Section 20 0517, "Penetrations for Mechanical, Plumbing, and Fire Suppression Systems."

J. Where pipe support members are welded to structural building framing, scrape, brush clean and apply one coat of zinc rich primer to welding.

K. Prepare pipe, fittings, supports and accessories not prefinished, ready for finish painting. Refer to Division 20 Section 20 9100, "Painting for Mechanical, Plumbing, and Fire Protection."

L. Install valves or cocks with stems upright or horizontal, not inverted.

M. Install all gas piping in compliance with all local codes and local gas utility company.

N. Provide one wrench for every ten square head cocks and plug cocks sized 2"] and smaller, minimum of one. Provide each plug cock sized 2½" and larger with a wrench with set screw.

2.13 APPLICATION

A. Install unions downstream of valves and cocks.

B. Install minimum shutoff cock 6" long dirt leg ANSI Z21.69 flexible gas hose connector, maximum 6 ft. long and union at gas fired equipment or apparatus connection.

C. Install gate, butterfly valves or cocks for shutoff and to isolate equipment, part of systems, or vertical risers.

2.14 WELDING

A. All welding shall be performed by experienced welders in a neat and workmanlike manner. Welding done on piping, pressure vessels and structural steel under this section shall be performed only by persons who are currently qualified in accordance with ANSI Standard Code for Pressure Piping, Section I, Power Piping, Bulletin ANSI B31.1.0-1980; applicable portions of ASME Boiler and Pressure Vessel Code, Section I, Power Boilers,; and Section IX, Welding Qualifications. Submit for approval and record certified copies of Procedure Specification for Welding, Welding Procedure Qualification Tests and Welder Performance Qualification Tests. Welding specifications and qualification tests shall be recorded on Forms Q-1, as recommended in Appendix II of Section IX of the ASME Boiler and Pressure Vessel Code. Records shall be certified by Contractor and shall be accessible to authorized inspector.

B. Bevel piping on both ends before welding as required and defined in Code.

C. Use following weld spacing on all butt-welds:

Nominal Pipe Wall Thick	Space
¼" or less	⅛"
Over ¼" or less than ¾"	3/16"
¾" and over	3/16"

D. Use backing rings on welds in all piping 3" and larger.

E. Before start of any welding, remove all corrosion and other foreign material from surface to be welded.

F. Welding shall be performed by either manual shielded metallic arc process or automatic submerged arc process. Use direct current exclusively.

G. Electrodes to be used with manual shielded metallic arc method shall conform to ASTM A-233, Classification E-6010.

H. Size of electrodes, voltages, current, thickness and number of passes or beads shall be in accordance with provisions of previous paragraph.

I. After deposition, clean each layer of weld metal to remove all slab and scale by wire brushing or grinding, then chip where necessary to prepare for proper deposition of next layer.

J. Weld reinforcement shall be not less than 1/16" nor more than ⅛" above normal surface of joined sections. Reinforcement shall be crowned at center and shall taper on each side

to surface being joined. Exposed surface of weld shall present workmanlike appearance and shall be free of depressions below surface of joined members.

K. No welding of any kind shall be done when temperature of base metal is lower than 0°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Temperature of metal shall be "warm to hand" – or approximately 60°F.

L. All welders engaged in work performed under this Section shall have been qualified in accordance with test requirements of Section IX of the ASME Boiler and Pressure Vessel Code. Each operator shall identify his production welds by marking his regularly assigned identification number or mark within 1" of weld. Contractor shall submit to Engineer complete list of individual numbers of identifying marks and operator's name. Copy of each operator's certificate shall be filed with Engineer.

M. Welds will be inspected visually by representatives of Owner and Contractor. Any weld judged defective by Owner from visual inspection shall be cut out and tested in presence of or his representative. In event any welder consistently produces high percentage of unsatisfactory production welds, he shall be discharged at request of Owner even though he is able to produce satisfactory welds when test expected in advance. Removal and replacement of test coupons and samplings shall be done at expense of Contractor.

2.15 FIELD TESTS

A. Furnish all labor material, instruments, supplies and services and bear all costs for the accomplishment of tests herein specified. Correct all defects appearing under test and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

B. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.

C. Perform all tests other than herein specified which may be required by legal authorities or by agencies to whose requirements this work is to conform.

D. Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no additional cost to the Owner.

E. No work shall be painted, backfilled or concealed until authorized by Owner's representatives.

F. Inform Owner's representative 48 hours prior to when work is ready for test.

G. Systems found to have leaks shall be subjected to further tests when faulty joints have been repaired or replaced.

H. Welded joints shall be subjected to a hammer test while under pressure. For additional test requirements see welding specification.

I. Fuel gas piping shall be pneumatically tested with air or inert gas for minimum of 24 hours at 50 psig.

J. Fuel oil secondary containment piping system shall be tested as per manufacturer's installation bulletin.

K. Test pressures shall be increased if necessary to comply with applicable codes.

2.16 SERVICE CONNECTIONS

A. Gas service distribution piping to have initial minimum pressure of 10" w.g. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

END OF SECTION

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SECTION 23 3113
METAL AND FLEXIBLE DUCT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Duct and duct-associated materials and procedures in this section include:

1. Sheet metal materials
2. Single-wall rectangular ducts and fittings
3. Double-wall rectangular ducts and fittings
4. Single-wall round ducts and fittings
5. Double-wall round ducts and fittings
6. Flexible ducts
7. Sealants and gaskets
8. Hangers and supports

B. Products/material specified under other Divisions but installed under this section:

1. Duct-mounted smoke detectors

C. Services provided

1. Duct leak testing
2. Removal of existing duct lining
3. Duct cleaning

1.2 DEFINITIONS

A. Duct Size: Duct sizes indicated herein or on associated drawings shall be the inside clear dimensions of actual air path for both unlined and lined ducts.

B. Pressure Class: A "SMACNA - HVAC Duct Construction Standards, Metal and Flexible" pressure classification system designating static pressure values (in inches w.g.) equal to the maximum operating pressure to which the ductwork can safely be subjected.

1.3 CODES AND STANDARDS (USE LATEST EDITIONS)

A. American Society for Testing Materials (ASTM)

1. ASTM A 36/A 36M: Specification for Carbon Structural Steel
2. ASTM A 366/A 366M: Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
3. ASTM A 480/A 480M: Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
4. ASTM A 653/A 653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
5. ASTM B 209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate
6. ASTM C 411: Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
7. ASTM C 534: Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
8. ASTM C 916: Specification for Adhesives for Duct Thermal Insulation
9. ASTM C 920: Specification for Elastomeric Joint Sealants
10. ASTM C 1071: Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)

11. ASTM E 84: Test Method for Surface Burning Characteristics of Building Materials

B. National Fire Protection Association (NFPA)

1. NFPA 90A: Installation of Air Conditioning and Ventilating Systems (ANSI)
2. NFPA 90B: Installation of Warm Air Heating and Air Conditioning Systems (ANSI)
3. NFPA 96: Ventilation Control and Fire Protection of Commercial Cooking Operations (ANSI)

C. North American Insulation Manufacturers Association (NAIMA)

1. NAIMA AH124: Fibrous Glass Duct Liner Standard

D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA: Duct Cleanliness for New Construction
2. SMACNA: HVAC Air Duct Leakage Test Manual
3. SMACNA: HVAC Duct Construction Standards - Metal and Flexible (excluding all amendments and proposed revisions)
4. SMACNA: IAQ Guidelines for Occupied Buildings Under Construction

E. Underwriters Laboratory

1. UL 181: Factory-Made Air Ducts and Air Connectors
2. UL 723: Test for Surface Burning Characteristics of Building Materials

1.4 QUALITY ASSURANCE

A. Construct ductwork to NFPA 90A standards.

B. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall, at a minimum, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," excluding all amendments and proposed revisions, and performance requirements and design criteria indicated.

1. All further references to conformance with the requirements of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" shall always mean with the exclusion of all amendments and proposed revisions.
2. Where the requirements of this specification exceed the requirements of the SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," the specifications shall govern.

C. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

D. Duct 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."

1.5 SUBMITTALS

A. Product Data: Submit for each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets: submit manufacturer's data sheets including performance data, pressure ratings, surface burning characteristic and installation instruction.

B. Shop Drawings: For all new duct systems submit layout drawings at ¼" = 1'-0" scale in both hard-copy and AutoCAD compatible format. Shop drawings shall include, but not be limited to:

1. Metal and flexible ductwork and fittings including both factory- and shop-fabricated
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes
4. Elevation of ducts
5. Dimensions of main duct runs from building grid lines
6. Fittings
7. Reinforcement and spacing
8. Seam and joint construction
9. Penetrations through fire-rated and other partitions
10. Equipment installation based on equipment being used on Project
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels
12. Hangers and supports, including methods for duct and building attachment, and vibration isolation
13. Provide detail or schedule of:
    a. Sheet metal thicknesses
    b. Joint and seam construction and sealing
    c. Reinforcement details and spacing
    d. Materials, fabrication, assembly, and spacing of hangers and supports
14. Shop drawings shall show other building and building system components for coordination purposes. Input from other installers shall be obtained. Any proposed changes to duct layout required for coordination purposes shall be indicated. Coordination items shown shall include but not be limited to:
    a. Any pipe (e.g., sprinkler, heating hot water, chilled water, plumbing pipes, roof drawings, etc.) in vicinity of duct
    b. Electrical duct banks and conduit
    c. Structural members including structural members to which duct will be attached
    d. Items penetrating finished ceiling including the following:
        (1) Lighting fixtures
        (2) Air outlets and inlets
        (3) Speakers
        (4) Sprinklers
        (5) Access panels

C. Manufacturer's Installation Instruction: Submit manufacturer's installation instructions for all manufactured ductwork.

D. Field record drawings

1. During the construction process, the Contractor shall maintain a set of drawings showing the exact routing and location of duct systems being installed. The drawings shall be updated neatly by hand on a daily basis and account for

routing modifications made in the field. Contractor shall use these drawings as a basis for generating the project as-built drawings.

E. As-built drawings

1. Upon completion of project, Contractor shall furnish as-built drawings showing in scale the exact routing and locations of all newly installed ductwork systems. Submit in both hard-copy and electronic AutoCAD format.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect new duct interiors from moisture, construction debris and dust, and other foreign materials. If inside of new duct becomes dirty, Contractor shall clean duct per Duct Cleaning specifications.

B. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Intermediate Level.

1.7 WARRANTY

A. One year warranty on products and complete installation commencing at the time of Substantial Completion.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

1. Galvanized Sheet Steel: Comply with ASTM A 653. Lock forming quality with G-90 galvanized coating designation (not less than 1.25 oz. of zinc on each side of each square foot of sheet).
2. Paint Grip Steel; mill-phosphatized "Paintgrip" or "Zincgrip" finish suitable for field painting.
3. Minimum ducts gauges shall be in accordance with the following table. This table shall be used in conjunction with SMACNA table for application of appropriate reinforcement in accordance with proper pressure class.

(1) Galvanized steel – rectangular duct:

Maximum Duct Dimension (in.)	Minimum Duct Gauge	Comments
Up to 10	26	pressure class 2" w.g.
Up to 10	24	pressure class greater than 2" w.g.
12 through 29	24	
30 through 53	22	
54 through 84	20	
Over 84	18	
Duct located out-of-doors	18	

(2) Galvanized steel – round duct:

Maximum Duct Dimension (in.)	Minimum Duct Gauge	
Up to 10	26	pressure class 2" w.g.
Up to 10	24	pressure class greater than 2" w.g.
11 thru 17	24	
18 thru 27	22	
28 thru 35	20	
35 thru 52	18	

B. Fasteners: Rivets, bolts, or sheet metal screws.

2.2 SINGLE WALL RECTANGULAR DUCTS AND FITTINGS (SHOP AND FACTORY FABRICATED)

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated
4. Shop fabricated duct is acceptable for ducts with a pressures class rating of 6" w.g. or less provided compliance with the requirements herein are met.

B. General Fabrication Requirements

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
2. Comply with SMACNA's "Industrial Duct Construction Standards" where indicated.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" except as otherwise noted.

1. No duct shall be constructed to less than 2" w.g.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," except as otherwise noted:

1. Button Punch Snap Lock is not acceptable.

E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," except as otherwise noted.

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS (FACTORY FABRICATED)

A. Acceptable Manufacturers

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. All double wall duct must be factory fabricated.

D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" except as otherwise noted.

   a. No duct shall be constructed to less than 2" w.g.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" except at otherwise noted:

   a. Button Punch Snap Lock is not acceptable.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity, k-value: 0.27 Btu x in./h x sq. ft. x °F at 75°F mean temperature.

   a. For ducts located outside the building envelope, provide a minimum of R-8 insulation (2½" of insulation based on a k-value of 0.27).
   b. For ducts located within the building envelope, provide a minimum of R-5 insulation (1½" of insulation based on a k-value of 0.27).
   c. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.

F. Inner Duct: Minimum 24 gauge (0.028") solid sheet steel.

1. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other

provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SINGLE-WALL ROUND DUCTS AND FITTINGS (FACTORY AND SHOP-FABRICATED)

A. Acceptable Manufacturers:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Shop fabricated ducts are acceptable for all positive pressure ducts and negative pressure ducts with ratings of -1" w.g. to -4" w.g.

B. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. All round ducts must utilize spiral lock seam except:

a. Ducts up to and including 12" diameter with a positive pressure class of 2" w.g. and less may utilize longitudinal lock seam construction.

C. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, and materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse joints in ducts larger than 60" in diameter shall be flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 48" in diameter with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.5 DOUBLE-WALL ROUND DUCTS AND FITTINGS (FACTORY FABRICATED)

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round

Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse joints in ducts larger than 60" in diameter shall be flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 48" in diameter with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Inner Duct: Minimum 24 gauge (0.028") solid sheet steel.

G. Interstitial Insulation:

1. Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
2. Maximum Thermal Conductivity, k-value: 0.27 Btu x in./h x sq. ft. x °F at 75°F mean temperature.
    a. For ducts located outside the building envelope, provide a minimum of R-8 insulation (2½" of insulation based on a k-value of 0.27).
    b. For ducts located within the building envelope, provide a minimum of R-5 insulation (1½" of insulation based on a k-value of 0.27).
    c. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.

2.6 SEALANT AND GASKETS

A. Acceptable Manufactures for Duct Sealant:

1. Hardcast
2. United McGill
3. Ductmate

B. 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.

C. Duct Sealant:

1. Water-based non hardening, water resistant, mold and mildew resistant sealant classified compounded specifically for sealing joints and seams in ductwork.
    a. Maximum Static-Pressure Class: 10" w.g., positive and negative.
    b. Service: Indoor or outdoor.
    c. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets for specific applications.

2. Duct tapes are not allowed.

D. Flanged Joint Sealant: Comply with ASTM C 920. General: Single-component, acid-curing, silicone, electrometric. Type S, Grade NS, Class 25, Use O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

1. Gaskets used in chemical, laboratory, or process exhaust duct systems shall be suitable for exposure to substances in the air stream. Contractor shall verify the compatibility with Engineer prior to installation.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Dry or Non-corrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Moist or Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 APPLICATION

A. Install duct with duct material for pressure class as per the following table:

Duct System and Location	Material	Pressure Class
Constant volume supply: all duct	Galvanized steel (G90)	+3″
Outside air and exhaust plenums	Galvanized steel (G90)	-2″
Return system with no air terminal units: all duct	Galvanized steel (G90)	-2″
Air relief and transfer	Galvanized steel (G90)	+2″

B. Utilize the following flexible ducts for the applications as outlined below:

3.2

INSTALLATION

A. General

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Where interferences develop in field, offset or reroute ductwork as required for clearing such interference.

2. Contractor shall modify specified duct sizes as required to fit. Modified duct size shall have cross-sectional area and pressure drop equivalent to that of the specified duct size.
3. All ducts shall be airtight and free from pulsation and vibration at normal operating conditions.
4. Contractor shall submit sheet metal shop drawings to the Test and Balance Contractor for review, and provide any additional volume dampers that the Test and Balancing Contractor needs to perform final balancing.
5. Install round ducts in maximum practical lengths.
6. Install ducts with fewest possible joints.
7. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
8. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
9. Install ducts with a minimum clearance of 1", plus allowance for insulation thickness.
10. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
11. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
12. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1½".
13. Where ducts pass through fire and smoke rated interior partitions and exterior walls, install fire, smoke, and/or combination fire/smoke dampers. Contractor shall obtain a copy of architectural drawings showing the fire and smoke rated partitions and exterior walls at the time of bid and provide the appropriate damper (at all ducts penetrating fire and smoke rated partitions and walls whether shown on mechanical plans or not). Comply with requirements in Division 23 Section "Ductwork Accessories" for fire and smoke dampers.
14. Provide openings in ducts where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ducts, install insulation material inside a metal ring.
15. Fabricate continuously welded medium and high pressure round duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4" cemented slip joint, brazed or electric welded. Prime coat welded joints.
16. Install duct-mounted smoke detectors.
17. Where ducts of different metals meet, joint shall use a gasket, seal or compound to prevent the two different metals from coming in contact.
18. Galvanized surfaces altered or damaged (including the damage due to welding) shall be painted with a galvanized paint.
19. For paint grip steel ducts, place identification stickers in side ducts off of the surface to be painted.
20. Gaskets shall not protrude into airstream.

21. Elbows:

    a. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

        (1) For supply duct:

            (a) Use Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

            (b) If space does not allow the use of a Radius Type RE1, provide a square-throated elbow with turning vanes. Turning vanes shall comply with the requirements of Division 23 Section "Ductwork Accessories".

        (2) For return and exhaust duct:

            (a) Use Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

            (b) If space does not allow the use of a Radius Type RE1, provide a square throated elbow with vanes. Turning vanes shall comply with the requirements of Division 23 Section "Duct Accessories."

                i) For return ducts that are less than 3 ft^2 cross-sectional area and serve hospital patient care areas, rectangular elbows with turning vanes are not allowed. If an RE-1 type radius elbow with a 1.5 radius-to-diameter ratio cannot be used, a 1.0 radius-to-diameter elbow is allowed.

    b. Round Duct, excluding laboratory (fume handling) exhaust duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

        (1) Use minimum 1.5 radius-to-diameter ratio.

            (a) 12" and Smaller in Diameter: Stamped (pleated not acceptable)

            (b) 14" and Larger in Diameter: Standing seam or welded five-piece 90 degree turning elbows (three-piece elbows not acceptable for 90 degree elbow).

            (c) 45 degree elbows shall meet the requirements for 90 degree elbows and shall be die stamped up to 12" and three piece construction of sized greater than 12".

22. Branch Configurations:

    a. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

        (1) Rectangular main to rectangular branch: 45-degree entry.

        (2) Rectangular main to round branch: Bellmouth connection. A 45 degree boot connection is allowed only where the duct main size does not allow the use of a Bellmouth branch connection.

        (3) No straight tap, butt flange or cinch lock is allowed

b. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees."

(1) Provide 45-degree lateral tap; conical taps are allowed only on supply duct downstream of air terminal units and return ducts upstream of air terminal units.

(2) Saddle taps are permitted only for new connection in existing duct.

(3) No 90 degree taps are allowed.

23. Offsets and transitions: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-7, "Offsets and Transitions."

a. Transitions:

(1) Increase duct sizes gradually, not exceeding 15 degrees on each side for a concentric transition or 30 degrees on one each side for an eccentric transition.

(2) Decrease duct sized not exceeding 22.5 degrees on each side for a concentric transition or 45 degrees on one side for an eccentric transition.

b. Offsets:

(1) Provide smooth radius offset with the radius equal to the duct dimension.

(2) Mitered offset Type 2 is acceptable provided the offset angle no greater than 15 degrees.

24. Easements for obstructions:

a. Provide easements where ductwork conflicts with piping and structure.

b. Where easements exceed 10% duct area, split into two ducts maintaining original duct area.

25. Seam and joint sealing:

a. For all new ducts, all transverse joints, longitudinal seams and connections shall be sealed in conformance with SMACNA Class A sealing requirements as defined in the 1995 SMACNA HVAC Duct Construction Standards - Metal and Flexible, Second Edition.

26. Hangers and supports: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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) Where practical, install concrete inserts before pouring concrete.

b. Support ducts using traverse steel and threaded rods or 1" wide straps of 16 gauge galvanized steel. Wire or perforated straps of any kind are not acceptable.

c. No hangers and supports shall be attached to ducts with sheet metal screws that penetrate any part of ducts.

d. Round duct shall be suspended on prefabricated circular single loop or two-piece bands completely encircling ducts.

e. Hanger Spacing: Except where requirements herein exceed, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct,"

(1) Provide duct supports at a maximum of 6 foot intervals, within 24" of each elbow, and within 24" of each branch intersection.

(2) Provide vertical ducts supports at a maximum of 10 foot intervals.

f. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

27. Flexible Duct:

a. Aluminum Laminate or Acoustic CPE Flexible Duct (Insulated or Noninsulated):

(1) Connect diffusers to low pressure ducts with a maximum of five feet of flexible duct.

(2) Each connection shall be a single piece of flexible duct. No splicing is allowed.

(3) Support flexible duct at a maximum of 2 feet on center, with no portion lying on suspended ceiling system or other horizontal surface.

(4) Flexible ducts shall not pass through any partition, wall, floor or ceiling.

(5) Connect fabric type flexible ducts to diffuser collars or duct with stainless steel draw bands with quick release. Position draw bands behind collar beads if applicable. Connection shall be airtight; seal if required for airtight connection.

END OF SECTION

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SECTION 23 3300
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Accessories addressed in this section include:

1. Manual volume dampers
2. Motorized control dampers
3. Fire dampers
4. Turning vanes
5. Duct access doors
6. Flexible connectors
7. Instrument test holes

B. Products/materials specified under other Divisions but installed under this Section:

1. Smoke detectors for smoke dampers and combination fire and smoke dampers.

1.2 DEFINITIONS

Not Applicable

1.3 CODES AND STANDARDS (UTILIZE LATEST EDITION)

A. Air Movement and Control Associates International (AMCA)

1. AMCA 500 - Test Methods for Louvers, Dampers and Shutters
2. AMCA 511 - Certified Ratings Program for Air Control Devices

B. National Fire Protection Association (NFPA)

1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

C. National Institute of Standards and Technology (NIST)

D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA - HVAC Duct Construction Standards-Metal and Flexible

E. Underwriters Laboratories (UL)

1. UL 555 - Standard for Safety Fire Dampers
2. UL 555C - Standard for Safety Ceiling Dampers
3. UL 555S - Standard for Safety Smoke Dampers

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

B. Ductwork specialties shall be designed and manufactured to conform to the same pressure class as the duct in which they are located, unless otherwise indicated to exceed.

1.5 SUBMITTALS

A. Prior to installing any ductwork accessories submit:

1. Product Data: Provide manufacturer's literature and illustrations for all components indicating materials, construction, quantities, size, dimensions and configuration.

2. Shop Drawings: Provide details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection for all products.
3. Manufacturer's Installation Instructions: Indicate specific installation instructions per the manufacturer of all products, and indicate how the system will be assembled for:
   a. Fire dampers
4. Coordination Drawings: Provide coordination reflected ceiling plans, drawn to scale showing penetrations, ceiling-mounting items, ceiling-mounting access panels and access doors required for access to duct accessories.

B. Submit operation and maintenance data for:
1. Motorized control dampers
2. Fire dampers

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Section 01 6000.

B. Deliver products to site in containers with manufacturer's and UL stamp affixed.

C. Protect products against dirt, water, chemical and mechanical damage before, during and after installation. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to the Owner.

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, except where otherwise indicated to exceed the requirements of the Standard.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation. For uninsulated ducts with surfaces exposed to view, provide paint grip steel; mill-phosphatized "Paintgrip" or "Zincgrip" finish suitable for field painting.

C. Stainless Steel: ASTM A 480/A 480M.

D. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and 1-side bright finish for exposed ducts.

E. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063, temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, ¼" minimum diameter for tie rod lengths of 36" or less; 3/8" minimum diameter for tie rod lengths longer than 36".

2.2 MANUAL VOLUME DAMPERS

A. Acceptable Manufacturers
1. Air Balance, Inc.
2. Nailor Industries, Inc.

3. Ruskin Company
4. Vent Products Company, Inc.

B. Quality Assurance

1. Include leakage, pressure drop, and maximum pressure data with submittals.
2. Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA500.
3. Field or shop fabricated manual volume dampers are not acceptable.

C. Standard Manual Volume Damper

1. Factory fabricated, rectangular or round damper with required hardware and accessories. Single-blade or multiple-opposed-blade design, with linkage outside airstream, and suitable for horizontal or vertical applications.
2. Performance data:
   a. Capacity: Demonstrate damper capacity to withstand HVAC system operating conditions.
      (1) Closed position: Maximum pressure of 3″ w.g.
      (2) Open position: Maximum air velocity of 1,500 fpm.
   b. Pressure drop:
      (1) Rectangular dampers: Maximum 0.10″ w.g. at 1,500 fpm across a 24″ x 24″ damper.
      (2) Round dampers: Maximum 0.02″ w.g. at 1,500 fpm across a 20″ diameter round damper.
3. Rectangular Damper Construction:
   a. Frame: Hat-shaped, galvanized sheet steel channels, minimum 16 gauge (0.064″ thick), with mitered and welded corners; frames with flanges where required for attaching to walls and flangeless frames for installing in ducts.
   b. Blades: Minimum 16 gauge (0.064″ thick), galvanized steel. For ducts 10″ in height and less, single blade dampers are acceptable. For ducts over 10″ in height, provide multiple blades of 8″ maximum width.
   c. Axles: ½″ diameter or hex full length plated steel rod
   d. Basis of Design: Ruskin Company Model MD35
4. Round Damper Construction:
   a. Frame: Minimum 0.036″ thick galvanized steel with flanges where indicated for attaching to walls
   b. Blades: Minimum 20 gauge (0.040″ thick) galvanized steel, maximum 16″ diameter
   c. Axles: Minimum 3/8″ square full length plated steel rod
   d. Basis of Design: Ruskin Company Model MDRS25

D. Jackshaft: 1″ diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware

1. Hand-Operated Damper Regulator:
    a. For all manual dampers provide a locking type hand quadrant operator with lever handle, position indicator and lock nut for all dampers.
    b. Provide a minimum of a 2" hand-quadrant stand-off elevated platform where damper is located in insulated ducts.

2.3 MOTORIZED CONTROL DAMPERS

A. Acceptable Manufacturers
1. Air Balance, Inc.
2. Johnson Controls
3. Ruskin Company
4. TAMCO (T.A. Morrison & Co. Inc.)
5. Vent Products Company, Inc.

B. Quality Assurance
1. Include leakage, pressure drop, and maximum pressure data with submittals.
2. Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA500.

C. Performance Data
1. Capacity: Demonstrate damper capacity to withstand HVAC system operating conditions.
    a. Closed Position: Maximum pressure of 13" w.g. at 12" blade length.
    b. Open Position: Maximum air velocity of 6,000 fpm.
2. Pressure drop: Maximum 0.03" w.g. at 1,500 fpm across 24" x 24"damper.
3. Leakage: Ultra-low leakage control dampers shall be leakage AMCA rating Class 1 (rated for a maximum of 4 cfm per square foot at 1" w.g. and 8 cfm per square foot at 4"w.g. static pressure).
4. Operating Temperature Range: From -40°F to 200°F

D. Damper Construction
1. Frame: 0.125" thick extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.
2. Blades: Minimum 0.625" thick extruded aluminum airfoil-shaped blades; maximum 6" wide with opposed or parallel blade action as required by the application.
3. Blade Seals: Inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals.
4. Axles: Minimum ½"diameter zinc-plated steel with thrust bearings at each end of every blade.
5. Maximum size of single sections 60" x 60".

E. Basis of Design: Ruskin Company Model CD-50

2.4 FIRE DAMPERS

A. Acceptable Manufacturers
1. Air Balance, Inc.
2. Greenheck
3. Nailor Industries, Inc.

4. Prefco Products, Inc.
5. Ruskin Company

B. Quality Assurance

1. Comply with NFPA 90A except where specification exceeds requirements of NFPA 90A.
2. Fire dampers shall be labeled according to UL 555.

C. Ratings

1. Fire rating: 1½ hour and/or 3 hours as required by wall rating.
2. All fire dampers shall be dynamic type dampers. Dampers located in ductwork constructed with a pressure classification of more than ±2" w.g. and at shaft walls shall be rated at a minimum of 4,000 fpm and 6" w.g. All other dampers shall be rated at a minimum of 3,000 fpm and 4" w.g. static pressure.

D. Curtain Type Fire Damper

1. Frame: Roll formed galvanized steel, minimum of 20 gauge (0.034" thick) with mitered and interlocking corners.
2. Blades: Roll formed galvanized steel, minimum of 24 gauge (0.028" thick), interlocking blades.
3. Mounting Sleeve: Factory or field installed, galvanized sheet metal
   a. If break-away style duct/sleeve connection is used, sleeve thickness shall be equal to or greater than the duct connected to the damper.
   b. If break-away style duct/sleeve connection is not used, the sleeve shall be a minimum of 16 gauge (.063" thick) for dampers up to 36" wide by 24" high and 14 gauge (.078" thick) for dampers exceeding 36" wide by 24" high.
4. Mounting Orientation: Vertical or horizontal. Provide blade lock and stainless steel closure springs for horizontal installations.
5. Basis of Design: Ruskin DIBD2 or DIBD23, Type B or C

2.5 TURNING VANES

A. Acceptable Manufacturers

1. Aero/Dyne Industries
2. Ductmate Industries, Inc.
3. Carlisle Harcast, Inc.

B. Quality Assurance

1. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for vanes and vane runners or provide Aero/Dyne HEP vanes. Vane runners shall automatically align vanes.
2. Vanes shall be factory fabricated on common base rail. Field fabricated vanes are not acceptable.

C. Construction

1. 2" or 4½" double-vane, curved blades of galvanized sheet steel set ¾" on center; support with bars perpendicular to blades set a maximum of 2" on center; and set into vane runners suitable for duct mounting.
2. Minimum 24 gauge vanes for ducts less than 30" wide.

3. Minimum 22 gauge vanes for ducts 30″ wide and greater.

2.6 FLEXIBLE CONNECTORS

A. Acceptable Manufacturers

1. Duro Dyne Corp.
2. Ventfabrics, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip minimum 4″ wide attached to two strips of 2¾″ wide, 24 gauge (0.028″ thick), galvanized sheet steel or 0.032″ thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz/sq yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: -40°F to +200°F

2.7 DUCT ACCESS DOORS

A. Acceptable Manufacturers

1. Air Balance, Inc.
2. FlexmasterUSA
3. Greenheck
4. McGill AirFlow Corporation
5. Nailor Industries, Inc.

B. Access Door Construction

1. General: Fabricate doors airtight and suitable for duct pressure class.
2. Doors shall be rectangular, close-fitting doors of galvanized steel with sealing gaskets, edge protection and quick fastening locking devices suitable for duct pressure class. Access doors with sheet metal screw fasteners are not acceptable.
3. Access doors located in insulated ductwork shall be double wall with insulation fill. Provide a minimum thickness of 1½″ insulation fill or thicker insulation as necessary to match the insulation thickness on duct in which the access door is located.
4. Provide number of hinges and locks as follows:
    a. Up to 18″ square: Two hinges and two sash locks.
    b. Up to 24″ x 48″: Three hinges and two compression latches with outside handles.
    c. Sizes 24″ x 48″ and larger: One additional hinge.
5. Provide viewing port for all access doors 24″ x 48″ and larger and where indicated.

2.8 INSTRUMENT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. General

1. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" except where otherwise noted to exceed the requirements of this Standard.
2. Provide duct accessories of materials suited to duct materials; use galvanized steel accessories in galvanized-steel, paint grip steel accessories in paint grip steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
3. Install accessories in accordance with manufacturer's instructions.
4. Contractor shall obtain the latest fire and smoke separation documents prior to the initiation of each portion of the project, and provide fire, smoke and/or combination fire and smoke dampers at all such separations.

B. Manual Volume Dampers

1. Utilize standard volume dampers for:
   a. supply airflow balancing downstream of terminal units,
   b. return and exhaust airflow balancing applications further than 30 feet from the return or exhaust fan.
2. Provide manual volume dampers for balancing at all points on supply, return and exhaust systems where branch ducts are taken from larger ducts and at duct or flexible take-offs to supply and return diffusers or registers.
3. Install at a minimum of two duct widths from branch takeoff.
4. When installing volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
5. When installing volume dampers in insulated duct, install regulator with elevated platform such that damper is accessible and adjustable without imparting damage to the insulation.
6. Close duct penetrations for damper components to seal duct consistent with pressure class.
7. Provide remote operated volume control dampers regulator(s) for inaccessible volume dampers.

C. Motorized Control Dampers

1. Where return air damper is located at the mixing box, orient the parallel blades of the damper such that the return airflow is directed toward the outside air intake when the damper is in a partially open position.
2. Size dampers for flow requirements of the applications. Provide blank-offs as required to mount control damper in ductwork.
3. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
4. Coordinate actuators for motorized controls dampers with the requirements of Division 23 Section 23 0901, "Temperature Control Hardware."

D. Fire Dampers

1. Use curtain type damper where size, pressure and velocity ratings of damper allows. Where curtain type dampers are acceptable:

a. Utilize "Type B" curtain type fire damper, with blades out of the airstream in the open position for

(1) Supply ductwork downstream of air terminal units (VAV boxes)
(2) Return distribution ductwork excluding return ductwork penetrating main mechanical room walls and main vertical shafts.
(3) Toilet exhaust and general exhaust
(4) Transfer air ductwork

b. Utilize "Type C" curtain type fire damper, with blades and frame out of the airstream in the open position for

(1) Supply ductwork upstream of air terminal units
(2) Return ductwork through mechanical room walls and main vertical shaft walls.
(3) [add any other ducts which have velocity greater than 2,500 fpm]

2. Install dampers within the fire rated barrier complete with mounting collars, retaining angles, connections to adjoining ductwork and duct access doors.

E. Turning Vanes

1. Utilize 2" radius double wall airfoil vanes in:

a. Supply distribution ductwork located downstream of air terminal units that is less than or equal to 18" wide.
b. Return exhaust distribution ductwork less than or equal to 18" wide.
c. Toilet and general exhaust distribution ductwork less than or equal to 18" wide.

2. Utilize 4½" double wall airfoil vanes in:

a. Supply distribution ductwork located downstream of air terminal units and greater than 18" wide.
b. All supply ductwork located upstream of air terminal units.
c. Return distribution ductwork greater than 18" wide.
d. Toilet and general exhaust distribution ductwork greater than 18" wide.

3. Install turning vanes for all rectangular square throat elbows, except in transfer air ducts. Install in accordance with SMACNA standards and manufacturer's recommendations.
4. Install tuning vanes tangential to airflow.

F. Flexible Connectors

1. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators. Installed width shall be not less than 4".
2. For fans developing static pressures of 5" w.g. and higher, cover flexible connectors with leaded vinyl sheet held in place with metal straps.

G. Duct Access Doors

1. Review locations prior to fabrication.

2. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows and anywhere that provisions for maintenance or service of duct-mounted equipment is required

   a. Before and after filters.
   b. Before and after coils, including reheat coils. Where a reheat coil is provided integral with a terminal unit, provide an access door after terminal unit coil.
   c. Downstream from, motorized control dampers and turning vanes.
   d. Adjacent to fire, smoke, or combination fire and smoke dampers, providing sufficient access to reset or reinstall fusible links.

      (1) Exterior of access doors for fire damper, smoke damper or combination fire/smoke damper access doors shall be labeled with letters not less than 0.5" in height reading "FIRE DAMPER", "SMOKE DAMPER," or "COMBINATION FIRE/SMOKE DAMPER". Labeling shall be permanently affixed.

   e. Before and after duct-mounted humidifiers. Access door downstream of humidifiers shall be on sides of duct.
   f. At airflow measuring stations.
   g. Any valve or actuator located within a duct or casing.
   h. At duct-mounted smoke detectors.

3. Provide duct access doors sufficient for required inspecting, adjusting and maintenance but not less than the dimension shown below (the duct dimension given is that in which the access door is to be located):

   a. For duct dimension up to 12": 8" x 8"
   b. For duct dimension 14 " to 21": 12" x 12"
   c. For duct dimension 22" to 48": 18" x 18"
   d. For ducts over 48": 2 doors at 18" x 18"
   e. For AFMSs: 24" x 24"

H. Instrument Test Holes

1. Provide duct test holes where indicated and required for testing and balancing purposes.
2. Provide only factory fabricated instrument test holes in ductwork with a pressure rating greater than 2" or less than -2".
3. Install visible above insulation.

3.2 TESTING, INSPECTIONS AND ADJUSTING

A. Manual Volume Dampers

1. Operate manual control dampers to verify full range of movement is possible. Correct any situation in which dampers cannot travel their full range of movement.
2. Adjust final positioning of manual-volume dampers as specified in Section 23 0593, "Testing, Adjusting, and Balancing for HVAC."
3. Operate remote manual volume damper operators to verify full range of movement of operator and damper.

B. Motorized Control Dampers

1. Operate motorized control dampers to verify full range of movement is possible. Correct any situation in which dampers cannot travel their full range of movement.

C. Fire Dampers

1. Contractor shall manually test each fire damper for proper operation by removing fusible link, and repair or replace any damper that does not close completely. Owner reserves the right to observe and have the authorities having jurisdiction observe all testing and resetting of fire and combination fire and smoke dampers.
    a. Provide documentation identifying dampers tested, their location and the test results.
    b. Provide documentation of re-testing of any dampers that failed the first test.

D. Turning Vanes

1. Inspect turning vanes for proper and secure installation.

E. Duct Access Doors

1. Inspect locations of access doors and verify that purpose of access door can be performed.

END OF SECTION

SECTION 23 3416
CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Products furnished and installed in this section

1. Centrifugal upblast roof exhaust fan

1.2 CODES AND STANDARDS (UTILIZE LATEST EDITION)

A. American National Standards Institute (ANSI)/American Bearing Manufacturers Association (ABMA)

1. ANSI/ABMA 9 - Load Ratings and Fatigue Life of Ball Bearings

B. Air Movement and Control Association, Inc. (AMCA)

1. AMCA 99 - Standard Handbook
2. AMCA 300 - Reverberant Room Method for Sound Testing of Fans
3. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
4. AMCA/ANSI Standard 204 - Balance Quality and Vibration Levels for Fans
5. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings
6. AMCA 320: Laboratory Method for Sound Testing of Fans Using Sounds Intensity
7. AMCA Standard 204-96 - Balance Quality and Vibration Levels for Fans

C. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

1. ASHRAE 51 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
2. ASHRAE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality

D. International Energy Conservation Code (IECC)

E. National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code
2. NFPA 90A- Installation of Air Conditioning and Ventilation Systems
3. NFPA 92A – Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences
4. NFPA 92B – Standard for Smoke Management Systems in Malls, Atria, and Large Spaces
5. NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

F. UL LLC (UL)

1. UL 507 – Electric Fans
2. UL 705 – Power Ventilators
3. UL 762 – Power Roof Ventilators for Restaurant Exhaust Applications

1.3 QUALITY ASSURANCE

A. Products in this section shall be tested and approved and comply with the most current editions of the following standards:

1. AMCA 211 – Certified Ratings Program – Product Rating Manual for Fan Air Performance
2. AMCA 311 – Certified Ratings Program – Product Rating Manual for Fan Sound Performance
3. ANSI/AMCA 210 – Laboratory methods of Testing Fans for Certified Aerodynamic Performance Rating
4. AMCA 300 – Reverberant Room Method for Sound Testing of Fans
5. AMCA 99 – Standards Handbook

B. Classification for Spark Resistant Construction, levels A, B, and C shall conform to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Provide the following product data:

1. Drawings indicating configuration and materials used in fabrication.
2. Certified fan performance curves with system operating conditions indicated. Airflow, static pressure and horsepower shall be clearly shown.
3. Fan schedule showing fan airflow, static pressure, fan speed, outlet velocity, drive type, absorbed power, and motor speed
4. Certified fan sound-power rating
5. Motor rating, efficiency, and electrical characteristics, including motor and electrical accessories
6. Material thickness and finishes, including color charts
7. Dampers, including housings, linkages, and operators
8. Roof curbs

B. Shop Drawings

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, motor location, method of field assembly, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring
3. Hangers and supports, including methods for duct and building attachment and vibration isolation
4. Vibration Isolation Base Details: Detail fabrication including anchorage and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
5. Coordination Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
    a. Roof framing and support members relative to duct penetrations
    b. Ceiling suspension assembly members
    c. Size and location of initial access modules for acoustical tile
    d. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings

C. Operating and Maintenance Data

1. Submit Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site in containers with manufacturer's and UL stamp affixed.

B. Protect products against dirt, water, chemical and mechanical damage before, during and after installation. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to the Owner.

C. Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finished during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.6 WARRANTY

A. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to and not a limitation of, other rights Owner may have under Contract Documents. Manufacturer's warranty should include the following:

1. Equipment should be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturer's option when returned to Manufacturer, transportation prepaid.
2. Motors warranty shall be by the motor manufacturer for a period of one year. Should motor prove to be defective during this period, it should be returned to the nearest authorized motor service station.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL UPBLAST ROOF EXHAUST FAN

A. Acceptable Manufacturers

1. Greenheck Fan Corporation
2. Loren Cook Company
3. Penn Barry
4. Twin City

B. Housing

1. Spun aluminum, upblast exhaust fan for roof-mounted application and rated for a maximum continuous operating temperature of 400°F.
2. Where indicated the fan shall be UL 762 rated and NFPA 96 compliant for the removal of smoke and grease-laden vapors from commercial cooking equipment.
3. Where indicated the fan shall be a UL listed Power Ventilator for Smoke Control Systems capable of withstanding a 500°F airstream temperature for a minimum of four hours and 1,000°F for a minimum of 15 minutes.
4. Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners.

5. Wind-band to include an integral rolled bead for strength.
6. Spun aluminum structural components shall be minimum 16 gauge aluminum, bolted to a rigid aluminum support structure.
7. Aluminum base shall have continuously welded curb cap corners.
8. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb.
9. Top cap shall have stainless steel quick release latches to provide access to the motor compartment without the use of tools.
10. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators and enclosed in a weather-tight compartment separated from the exhaust airstream.
11. Fan shall include lifting lugs to facilitate proper installation.
12. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number, serial number, design airflow, design static pressure, and maximum fan rpm.

C. Wheel

1. Aluminum, backward inclined, non-overloading centrifugal wheel
2. Wheel shall be dynamically balanced to Balance Quality Grade G6.3 per ANSI S2.19. Each assembled fan shall be test run at the factory at the specified fan rpm. Vibration signatures shall be taken on each fan bearing in the horizontal, vertical, and axial directions. The maximum allowable fan vibration level shall be 0.15 in/sec peak velocity, filter in, at the fan rpm when the fan is rigidly mounted.
3. Where indicated, the fan shall have a non-stick coating to prevent grease build up.

D. Motor – premium efficiency EC motor in compliance with Division 20 Specification 20 0513, "Motor Requirements for Mechanical, Plumbing, and Fire Suppression Equipment."

E. Drive Type

1. Direct Drive
    a. Where indicated the fan wheel shall be directly connected to the motor without a belt of other device to transmit power.

F. Finish

1. Plain finish – no factory applied finish.

G. Roof curb

1. 18 gauge galvanized steel roof curb with 1 1/2" thick, 3 pound per cubic foot density insulation, continuously welded joints, and lap jointed wood nailers designed for use with insulated roof decks.
2. Interior liner – Curb liner constructed of the same material as the curb to protect the insulation from the airstream.
3. Insect screen base – Base installed between the equipment and the roof curb with bolted access doors for removal and cleaning of an aluminum fine mesh insect screen.

4. Damper tray – Flanged to allow for damper to be placed in tray and fastened.
5. Height: 18"
6. Accessories:
    a. For all fan applications: These accessories shall be provided on all fans for all applications:
        (1) Curb seal – Rubber seal between the fan and the roof curb.
        (2) .
        (3) Drain Connection - Aluminum drain connection for single-point drainage of grease, water or other residues.
        (4) Potentiometer dial for EC motor speed adjustment.
        (5) Bird Screen – Aluminum bird screen to protect the fan discharge.

H. Basis of Design: Greenheck Model CUE, Loren Cook Model ACRUD/ACRUB/ASCS, Penn Barry Model Fumex, Twin City DCRU(R)/BCRU(R), BCRUSH

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not operate fans for any purpose until ductwork is clean, filters are in place, belts have proper tension, bearings lubricated and fan has been test run under observation.

B. Lift and support units with manufacturer's designated lifting or supporting points.

C. Where indicated install roof curb on roof structure, level and secure. Install and secure fans on curbs and coordinate roof penetrations and flashing with roof construction.

D. Install fans with flexible electrical leads and vibration isolation as indicated in Division 20 Specification 20 0548, "Vibration Isolation for Mechanical, Plumbing and Fire Suppression".

E. Install flexible connections specified in Division 23 Section 23 3300, "Ductwork Accessories," between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 1" flex between ductwork and fan while running.

F. Provide one extra set of fixed sheaves for final air balance.

G. Provide safety screen where inlet or outlet is exposed.

H. Pipe scroll drains to nearest floor drain.

3.2 FIELD INSPECTION AND REPORT

A. Provide report, in accordance with Division 01 Section 01 4000, "Quality Control Services," prepared by manufacturer's representative, stating that systems installed and services provided under this Section are in accordance with manufacturer's recommendations and are properly operating.

END OF SECTION

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SECTION 23 3600
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Products furnished and installed in this section

1. Fan powered terminal units – parallel fan
2. Single duct terminal units – commercial grade
3. Integral electric coil

1.2 DEFINITIONS

A. ETL – Electrical Testing Laboratories

1.3 CODES AND STANDARDS (UTILIZE LATEST EDITION)

A. Air Conditioning & Refrigeration Institute (ARI)

1. ARI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils
2. ARI 880 – Air Terminals

B. Air Diffusion Council (ADC)

1. ADC 1062 – Air Distribution and Control Device Test Code

C. Air Movement and Control Association, Inc. (ACMA)

1. AMCA 500 – Laboratory Methods of Testing Dampers for Rating

D. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

1. ASHRAE Standard 52 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
2. ASHRAE Standard 62 – Ventilation for Acceptable Indoor Air Quality

E. International Energy Conservation Code (IECC)

F. ASTM International (ASTM)

1. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E96 – Standard Test Method for Water Vapor Transmission of Materials

G. National Electrical Manufacturers Association (NEMA)

1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

H. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electrical Code
2. NFPA 90A – Installation of Air Conditioning and Ventilation Systems

I. Underwriters Laboratories (UL)

1. UL 181 – Factory-Made Air Ducts and Air Connectors
2. UL 723 – Tests for Surface Burning Characteristics of Building Materials
3. UL 1996 – Duct Heaters

1.4 QUALITY ASSURANCE

A. Products in this section shall be tested and approved and comply with the most current editions of the following standards:

1. Unit performance shall be determined in strict accordance with ARI 880 in an ARI certified laboratory.
2. Products requiring electrical connection shall be listed and classified by UL.
3. Insulation and liner shall meet all requirements of:
    a. NFPA 90A and UL 181
    b. ASTM E84, NFPA 255, and UL 723 and for flame and smoke spread
    c. UL 181 for mold growth and humidity
    d. ASTM E96 for water and vapor transmission
4. Coils shall comply with ARI Standard 410.
5. Box access door leakage ratings shall be based on tests and procedures performed in accordance with AMCA 500.
6. Electric heating coils shall be ETL listed and tested in accordance with UL 1996 and the NEC.
7. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004 Section 5.
8. Filters shall comply with the minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1.5 SUBMITTALS

A. Product Data: Provide product data for the following:

1. Air terminal units – product data shall include:
    a. Drawings indicating configuration, general assembly and materials used in fabrication.
    b. Performance schedule clearly indicating airflow, static pressure drop (including coil, sound attenuator etc.), discharge and radiated sound power level for the second through sixth octave bands at inlet static pressures of 1" w.g to 4" w.g in increments of 1" w.g.
        (1) Where applicable provide hot water reheat coil data including number of rows, capacity, flow rate, coil inlet and leaving air temperatures, coil inlet and leaving water temperature, and water pressure drop.
        (2) Where applicable provide electric reheat coil data including kW, coil inlet and leaving air temperatures and stages of control.
    c. Performance ratings indicating casing leakage, access door leakage, damper leakage, and accuracy of airflow control for each size of terminal unit provided.
    d. Electrical characteristics and connection requirements
2. Access doors used in air terminal units
    a. Indicate configuration, general assembly and materials used in fabrication.
    b. Provide leakage data in cfm per square foot at 1.0" w.g.
3. Liners and adhesives used in air terminal units
4. Sealants and gaskets used in air terminal units
5. Motors for fan powered terminal units – indicate motor efficiency

B. Shop Drawings

1. For air terminal units include plans, elevations, sections, details, and attachments to other work.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Wiring Diagrams: For power, signal, and control wiring.
4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Operating and Maintenance Data

1. Submit operation and maintenance data: Include manufacturer's descriptive literature, operating instructions, installation instructions and maintenance and repair data.
    a. Include directions for resetting terminal unit regulators, minimum and minimum airflows, and other adjustable settings.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site in containers with manufacturer's and UL stamp affixed.

B. Protect products against dirt, water, chemical and mechanical damage before, during and after installation. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to the Owner.

1.7 SPARE PARTS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. For Fan Powered Terminal Units
    a. Filters: Furnish one spare filter(s) for each filters installed.

PART 2 - PRODUCTS

2.1 FAN POWERED TERMINAL UNITS - PARALLEL FAN

A. Acceptable Manufacturers

1. Trane
2. Nailor Industries, Inc
3. Price Industries
4. Titus

B. Performance

1. Terminals shall be certified under the ARI Standard 880 Certification Program and carry the ARI Seal.
2. Terminals shall be designed, built and tested as a single unit including motor and fan assembly, primary air damper assembly, water or electric heating coils and accessories as shipped.
3. All electrical components shall be UL listed and installed in accordance with UL standard 1995.
4. The entire terminal shall be ETL listed as a complete assembly.
5. The damper shall be constructed to hold maximum leakage to 1% of the maximum rated airflow at 3" w.g.

6. Sound ratings for the terminals shall not exceed those indicated on drawings. Sound performance shall be ARI certified. The radiated and discharge path attenuation function for the specified NC shall be based upon factors found in ARI Standard 885-98. No additional attenuation factors shall be deducted from the sound power.

C. Casing

1. The terminal casing shall be minimum 22 gauge galvanized steel.
2. The terminal casing shall be lined with 1/2" foil faced dual density fiberglass insulation which complies with UL 181 and NFPA 90A. All exposed insulation edges shall be coated with a NFPA 90A approved sealant or encapsulated with metal to prevent entrainment of fibers in the airstream.
3. All parts of the terminal unit assembly, including any extra sections required for locating accessories such as access doors, shall be lined with the same material as the basic terminal unit. No field installed exterior insulation shall be required.
4. The terminal casing shall have an access door which allows removal of the fan and servicing of the terminal unit, including the heating coil, without disturbing duct connections.
    a. The door and frame shall be a minimum 22 gauge roll formed, galvanized steel and be lined with the same material and thickness of the casing.
    b. The door shall be removable and fastened with manually operated cam locks or screws.
    c. Seals: Foam gasket, between door and frame and between frame and duct to limit leakage. Access door leakage shall not exceed 0.20 cfm per square foot at 1" w.g. ratings in accordance with AMCA 500.
5. All electrical components, including low voltage controls, shall be mounted in sheet metal control enclosures.

D. Fan

1. The fan shall be constructed of steel and have a forward curved, dynamically balanced wheel with direct drive motor.
2. The motor shall be permanent split capacitor type with integral thermal overload protection and permanently lubricated bearings and shall be specifically designed for use with an SCR for fan speed adjustment.
3. Fan assembly shall include a tuned spring steel suspension and isolation between motor and fan housing.

E. Damper

1. The primary air damper shall be heavy gauge steel with shaft rotating in acetal resin self-lubricating bearings.
2. The primary air damper shaft shall be clearly marked on the end to indicate damper position. Stickers and other removable markings are not acceptable.
3. The primary air damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage.

F. Airflow Sensor

1. Differential pressure sensor shall be cross shaped multi-point quadrant averaging type with four flow quadrants. The sensor shall output an amplified differential pressure signal.
2. The sensor shall provide a minimum differential pressure signal of 0.03" w.g. at an inlet velocity of 500 fpm and a control signal accuracy of ±5% with the same inlet size at any inlet condition.
3. All piping connections to the flow sensor must be made with external ports.

G. Attenuator

1. Provide a plenum sound attenuator that is factory fabricated by the unit manufacturer for field installation.
2. Casing shall be constructed of 22 gauge galvanized steel and lined with 1" glass fiber with foil facing. All insulation edges shall be encapsulated with metal to prevent erosion into the airstream.

H. Temperature Control

1. General
   a. The terminal units' sequences of operation shall be as shown on the drawings.
2. Fan Speed Control
   a. The terminal shall utilize a manual SCR, which allows continuously adjustable fan speed from maximum to minimum, as a means of setting fan airflow.
   b. The speed control shall incorporate a minimum voltage stop to insure the motor cannot operate in a stall mode.
3. Direct Digital Control
   a. The temperature controls contractor shall furnish direct digital control terminal unit controllers and electronic damper actuators to the terminal unit manufacturer for factory installation by the terminal unit manufacturer.

I. Basis of Design: Trane VPEF

2.2 SINGLE DUCT TERMINAL UNITS – COMMERCIAL GRADE

A. Acceptable Manufacturers

1. Trane
2. Nailor Industries, Inc.
3. Price Industries
4. Titus

B. Performance

1. Terminals shall be certified under the ARI Standard 880 Certification Program and carry the ARI Seal.
2. Terminal units shall be capable of controlling air volume to ±5% of air volume setpoint with variations of inlet pressures from 0.10" w.g to 6" w.g.
3. The terminal casing shall be constructed to hold maximum leakage to 1% of the maximum rated airflow at 1" w.g.

4. The damper shall be constructed to hold maximum leakage to 1% of the maximum rated airflow at 3" w.g.
5. At an inlet velocity of 2,000 fpm, the minimum static pressure required to operate any terminal size shall not exceed 0.13" w.g.
6. Sound ratings for the terminals shall not exceed those indicated on drawings. Sound performance shall be ARI certified. The radiated and discharge path attenuation function for the specified NC shall be based upon factors found in ARI Standard 885-98. No additional attenuation factors shall be deducted from the sound power.

C. Casing

1. The terminal casing shall be minimum 22 gauge galvanized steel.
   a. The terminal casing shall be lined with 1/2" foil faced dual density fiberglass insulation which complies with UL 181 and NFPA 90A. All exposed insulation edges shall be coated with a NFPA 90A approved sealant or encapsulated with metal to prevent entrainment of fibers in the airstreamAll parts of the terminal unit assembly, including any extra sections required to accommodate specified accessories such as access doors, shall be lined with the same material in the same thickness as the basic terminal unit. No field installed exterior insulation shall be required.
2. For terminal units with a reheat coil, the terminal casing shall have a bottom access door to provide access to the upstream side of the heating coil:
   a. The access door and frame shall be a minimum 22 gauge roll formed, galvanized steel and be lined with the same material and thickness of the casing.
   b. For boxes size 12" and small, the access doors shall be a minimum of 10"x 8". For box sizes 14 and 16, access doors shall be a minimum of 10"x 12".
   c. The door shall be removable and fastened with manually operated cam locks or screws.
   d. Seals: Foam gasket, between door and frame and between frame and duct to limit leakage. Access door leakage shall not exceed 0.20 cfm per square foot at 1" w.g. ratings in accordance with AMCA 500.
3. The terminal casing inlet connection shall be round stub or slip and drive construction.
4. The terminal casing discharge connection shall be slip and drive construction for attachment to metal ductwork.

D. Damper

1. The damper shall be heavy gauge steel with shaft rotating in acetal resin self-lubricating bearings.
2. Shaft shall be clearly marked on the end to indicate damper position. Stickers and other removable markings are not acceptable.
3. The damper shall incorporate a mechanical stop to prevent over-stroking and a synthetic seal or gasket to limit close-off leakage.

E. Airflow Sensor

1. Differential pressure sensor shall be cross shaped multi-point quadrant averaging type with four flow quadrants. The sensor shall output an amplified differential pressure signal.
2. The sensor shall provide a minimum differential pressure signal of 0.03" w.g. at an inlet velocity of 500 fpm and a control signal accuracy of ±5% with the same inlet size at any inlet condition.
3. All piping connections to the flow sensor must be made with external ports.

F. Temperature Controls

1. General
   a. The terminal units' sequences of operation shall be as shown on the drawings.
   b. Terminal units utilized for constant volume applications shall be provided with the same controller as the variable air volume applications with the minimum and maximum airflow setpoints set to equal values.
2. Direct Digital Control
   a. The temperature controls contractor shall furnish direct digital control terminal unit controllers and electronic damper actuators to the terminal unit manufacturer for factory installation by the terminal unit manufacturer.

G. Basis of Design: Trane VCEF

2.3 INTEGRAL ELECTRIC COIL

A. Acceptable Manufacturers

1. Trane
2. Nailor Industries, Inc.
3. Price Industries
4. Titus

B. Construction

1. Electric coil shall be housed in a section integral with the terminal unit with an element grid recessed a minimum of 5 inches from the unit discharge.
2. Coil casing shall be constructed of minimum 20-gauge galvanized steel with slip and drive connections.
3. Electric coil elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3½" apart, staggered for maximum thermal transfer and element life, and balanced to ensure equal output per step.
4. The integral control panel shall be house in a NEMA 1 enclosure with hinged access door for access to all controls and safety devices.

C. Performance

1. Electric coils shall be ETL listed for zero clearance and tested in accordance with UL 1996 and the NEC.

D. Controls

1. General

a. The electric coils' sequences of operation shall be as shown on the drawings

2. Singe duct terminals - Electric coils shall contain a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, differential pressure airflow switch for proof of flow, line terminal block and an integral door interlock disconnect switch.
3. Fan-powered terminals - Electric coils shall contain a primary automatic reset thermal cutout, a secondary replaceable heat limiter per element, differential pressure airflow switch for proof of flow, line terminal block and an integral door interlock disconnect switch.
4. Heaters shall be equipped with a solid state relay controller to provide proportional control of electric heat.
5. A coil discharge air temperature sensor shall be provided to modulate the discharge temperature between maximum temperature setting and initial temperature of incoming air before heating. The discharge air temperature sensor shall also act as a high limit temperature sensor to prevent the electric coil from overheating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions except where instruction below exceed the manufacturer's instructions.

B. Locate all terminal units for unobstructed access to unit access panels, controls and valving. If terminal unit is located above a ceiling that is not easily removable, provide a removable ceiling component or ceiling access doors.

C. Install air terminal units with a minimum of 36" of straight duct upstream of inlet flow sensor.

D. Provide a minimum of 36" clearance on controller side of the air terminal unit. The clearance area shall extend the full length of the air terminal unit.

E. Support each terminal unit individually from structure. Do not support from adjacent ductwork.

F. Label each terminal unit with the Owner approved unique identifier. Label shall be on the bottom and side of the unit in accordance with Division 20 Section 20 0553, "Identification for Mechanical, Plumbing, and Fire Protection Systems."

G. Connect to ductwork in accordance with Division 23 Section 23 3113, "Metal and Flexible Duct."

H. If applicable, verify that electric power is available and of the correct characteristics.

I. Additional requirements for fan-powered terminal units:

1. Repair or replace duct insulation where retrofit terminal unit has been installed. Insulate the duct in which the terminal unit has been installed to match existing. Seal all insulation air tight. Do not insulate over damper actuator.

3.2 ADJUSTING

A. Coordinate adjustment of air terminal units with Division 23 Section 23 0593, "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION

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SECTION 23 3713
AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Products covered in this section include:

1. General use diffusers, registers and grilles

a. Square louvered flush face diffuser
b. Supply grille or register
c. Return and exhaust grille or register
d. Ceiling or wall transfer air grille
e. Security ceiling or wall transfer grille

1.2 DEFINITIONS

A. Diffusers: Elements arranged to deflect air through a large angle and to create local high-ratio mixing; typically located in ceilings.

B. Grilles: Louvered or perforated coverings for openings in air passages, which can be located in sidewalls, ceilings, or floors.

C. Registers: Combination grille and damper assemblies over air openings.

1.3 CODES AND STANDARDS (USE LATEST EDITIONS)

A. American Architectural Manufacturers Association (AAMA)

1. AAMA 605.2 - High Performance Organic Coatings on Architectural Extrusions and Panels

B. Air Movement & Control Association International, Inc. (AMCA)

1. AMCA 500 - Test Methods for Louvers, Dampers and Shutters
2. AMCA 511 - Certified Ratings Program for Air Control Devices

C. American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)

1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets

D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA - HVAC Duct Construction Standards-Metal and Flexible

1.4 QUALITY ASSURANCE

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

B. Louver ratings shall be based on tests and procedures performed in accordance with AMCA 511. Louvers shall be provided with an AMCA Certified Rating Seal for air performance and water penetration.

1.5 SUBMITTALS

A. Product Data: For each type of product provide the following product data:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

B. For Diffuser Registers and Grilles:

1. Provide a diffuser, register, and grille schedule indicating drawing designation, room location, quantity, model number, size, material and color, accessories furnished.

PART 2 - PRODUCTS

2.1 GENERAL USE DIFFUSERS, REGISTERS AND GRILLES

A. Acceptable Manufacturers

1. Krueger
2. Nailor Industries, Inc.
3. Price Industries
4. Raymon-Donco
5. Titus

B. General

1. Diffuser color shall be standard white unless indicated otherwise.
2. Unless otherwise noted diffusers, registers and grilles shall be fabricated of heavy gauge steel except in locations defined below:
   a. Devices used in areas subject to moisture (locker and shower rooms) shall be heavy gauge extruded aluminum.
   b. Devices located in stainless steel duct shall be stainless steel.
3. Contractor to provide type of frame compatible with the ceiling type including but not limited to T-Bar, spline or plaster ceiling.
4. Refer to drawing schedule for opposed blade damper requirements in supply diffusers. If damper is required by the drawing schedule, provide radial opposed blade damper operable from diffuser face.

C. Square or Rectangular Louvered Flush Face Diffuser

1. Rectangular ceiling diffusers with adjustable pattern and removable center core to discharge air in a 1-, 2-, 3- or 4-way pattern as indicated on the drawings.
2. Diffuser shall be high capacity.
3. These diffusers shall have a square or rectangular neck of the sizes indicated on the drawings. The square or rectangular neck shall be an integral part of the backpan.
4. Basis of Design: Titus Model TDC

D. Supply Grille or Register

1. Grilles shall be double deflection of sizes shown on the drawings.
2. The deflection blades shall be parallel to short dimension. Blades shall be spaced 3/4" and shall have friction pivots on both sides. Plastic blade pivots are not acceptable.
3. Border shall be 1-1/4" with countersunk screw holes.
4. Basis of Design: Titus Model 300RS

E. Return and Exhaust Grille or Register

1. Grilles shall have fixed deflection blades with 3/4" spacing and shall be of sizes shown on the drawings. Blades shall be parallel to long direction.

2. Border shall be 1-1/4" with countersunk screw holes.
3. Basis of Design: Titus Model 350RL

F. Ceiling or Wall Transfer Air Grilles

1. Transfer grilles shall have egg crate face and shall be of sizes shown on the drawings. Border shall be 1-1/4" with countersunk screw holes.
2. Basis of Design: Titus Model 50R

G. Security Ceiling or Wall Transfer Air Grilles

1. Transfer grilles shall have a 12 GA steel lattice face with 13/16" square holes on 1" centers and shall be of sizes shown on the drawings.
2. Border shall be 1-1/4" with countersunk screw holes.
3. Basis of Design: Titus Model SG-LFF
4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items level and plumb.

B. Clean/repair damaged surfaces in accordance with manufacturer's instructions.

C. Additional requirements for all diffusers, registers and grilles including critical environment diffuser:

1. Check location of ceiling mounted diffusers, registers and grilles and make necessary adjustments in position to conform to architectural reflected ceiling plans. Where architectural features or other items conflict with installation, notify Architect/Engineer for a determination of final location.
2. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers. Seal all seams in accordance with ductwork construction requirements.
3. Provide balancing dampers on every duct take-off to each diffusers, register or grille regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.
4. Frames for diffusers, grilles and registers located in plaster walls or ceilings shall be set prior to plastering.
5. Field insulate linear slot diffuser plenums on exterior of plenum with insulation of thickness and type same as supply ductwork insulation.
6. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.
7. Contractor shall maintain minimum distances from air intakes to plumbing vents and/or exhaust openings as specified in International Mechanical code and local codes having jurisdiction.

END OF SECTION

SECTION 23 7339
PACKAGED DIRECT FIRED MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged direct fired make-up air unit

B. Unit controls

1.2 REFERENCES

A. Air Conditioning and Refrigeration Institute (ARI)

1. ARI 210 - Unitary Air-Conditioning Equipment
2. ARI 240 - Air Source Unitary Heat Pump Equipment
3. ARI 270 - Sound Rating of Outdoor Unitary Equipment

B. National Fire Protection Association (NFPA)

1. NFPA 90A - Installation of Air Conditioning and Ventilation Systems

1.3 SUBMITTALS

A. Submit shop drawings and product data for manufactured products and assemblies required for this project.

B. Indicate electrical service and duct connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listing.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store and protect products under provisions of General Conditions and Division 01.

B. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.6 WARRANTY

A. Provide one year manufacturer's warranty under provisions of Division 01.

1.7 EXTRA MATERIALS

A. Provide one set of filters under provisions of General Conditions and Division 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Trane

B. Carrier

2.2 MANUFACTURED UNITS

A. Provide packaged units having gas burner.

B. Unit shall be self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, burner, controls, air filters, and mixed air section with dampers.

2.3 FABRICATION

A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners.. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.

B. Insulation: ½"thick foil-faced glass fiber on surfaces where conditioned air is handled. Protect edges from erosion.

C. Burner: The burner section shall be constructed of rust resistant cast iron bodies drilled to discharge fuel between diverging stainless steel mixing plates. Burner shall be capable of a modulating turndown ratio of 25 to 1. The burner assembly and gas manifold shall be completely pre-piped and factory tested. The operation of the burner shall be programmed through the flame safeguard with timed pre-purge and flame sensing.

D. Supply Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley, and rubber isolated hinge mounted motor. Unit shall include VFD for supply fan for variable air volume operation of the unit. Isolate complete fan assembly. Air Filters: 2" thick glass fiber disposable media in metal frames.

2.4 MIXED AIR DAMPERS SECTION

A. Dampers: Provide outside and return dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fall to closed position. Unit shall include relief/exhaust air fan.

B. Gaskets: Provide tight fitting dampers with edge gaskets.

C. Damper Operator: 24 volt with gear train sealed in oil, with spring return on units 7.5 ton cooling capacity and larger.

D. Mixed Air Controls: Modulate mixed air dampers to maintain the mixed air temperature setting.

2.5 OPERATING CONTROLS

A. Provide low voltage, adjustable thermostat to control burner operation and supply fan to maintain temperature setting.

B. Provide a LON digital controller capable of communicating with an existing Trance Tracer BCU.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that proper gas piping is available and installed.

B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.3 FIELD INSPECTION AND REPORT

A. Provide report, in accordance with Division 01, prepared by manufacturer's representative, stating that systems installed and services provided under this Section are in accordance with manufacturer's recommendations and are properly operating.

END OF SECTION

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SECTION 23 7413
PACKAGED ROOF TOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged roof top unit

B. Unit controls

C. Roof mounting frame and base

D. Maintenance service

1.2 REFERENCES

A. Air Conditioning and Refrigeration Institute (ARI)

1. ARI 210 - Unitary Air-Conditioning Equipment
2. ARI 240 - Air Source Unitary Heat Pump Equipment
3. ARI 270 - Sound Rating of Outdoor Unitary Equipment

B. National Fire Protection Association (NFPA)

1. NFPA 90A - Installation of Air Conditioning and Ventilation Systems

1.3 SUBMITTALS

A. Submit shop drawings and product data for manufactured products and assemblies required for this project.

B. Indicate electrical service and duct connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listing.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store and protect products under provisions of General Conditions and Division 01.

B. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.6 WARRANTY

A. Provide five year manufacturer's warranty under provisions of Division 01.

B. Warranty: Include coverage of refrigeration compressors.

1.7 EXTRA MATERIALS

A. Provide one set of filters under provisions of General Conditions and Division 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Trane

B. Carrier

C. Mammoth

D. McQuay

2.2 MANUFACTURED UNITS

A. Provide roof-mounted units having gas burner and electric refrigeration.

B. Unit shall be self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

2.3 FABRICATION

A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners.. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.

B. Insulation: ½"thick foil-faced glass fiber on surfaces where conditioned air is handled. Protect edges from erosion.

C. Heat Exchangers: Stainless steel, of welded construction.

D. Supply Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley, and rubber isolated hinge mounted motor. Unit shall include VFD for supply fan for variable air volume operation of the unit. Isolate complete fan assembly. Air Filters: 2" thick glass fiber disposable media in metal frames.

E. Roof Mounting Frame: 24" high galvanized steel, channel frame with gaskets, nailer strips.

2.4 BURNER

A. Gas Burner: Forced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device and automatic 100% shut-off pilot.

B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor and, after air flow proven and slight delay, allow gas valve to open.

C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting; de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.

D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, or adjustable time delay relays with switch for continuous fan operation.

2.5 EVAPORATOR COIL

A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.

B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less; provide thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.6 COMPRESSOR

A. Provide hermetic or semi-hermetic compressor, 3,600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports and filter drier.

B. Five minute timed off circuit shall delay compressor start.

C. Outdoor thermostat shall energize compressor above 57°F ambient.

D. Provide step capacity control by cycling compressors.

2.7 CONDENSER

A. Provide copper tube aluminum fin coil assembly with sub-cooling rows.

B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor.

C. Provide refrigerant pressure switches or outdoor thermostat to cycle condenser fans.

2.8 MIXED AIR DAMPERS SECTION

A. Dampers: Provide outside, return and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fall to closed position. Unit shall include relief/exhaust air fan.

B. Gaskets: Provide tight fitting dampers with edge gaskets.

C. Damper Operator: 24 volt with gear train sealed in oil, with spring return on units 7.5 ton cooling capacity and larger.

D. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and [when ambient air enthalpy exceeds return air enthalpy.

2.9 OPERATING CONTROLS - SINGLE ZONE UNITS

A. Electric solid state microcomputer based room thermostat, located as indicated in service area with remote sensor located as indicated. Controller shall be capable of LON communication with an existing Trane Tracer BCU.

B. Room thermostat shall incorporate:

1. Automatic switching from heating to cooling
2. Preferential rate control to minimize overshoot and deviation from setpoint
3. Set-up for four separate temperatures per day
4. Instant override of setpoint for continuous or timed period from one hour to 31 days
5. Short cycle protection
6. Programming based on weekdays, Saturday and Sunday
7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto

C. Room thermostat display shall include:

1. Time of day
2. Actual room temperature

3. Programmed temperature
4. Programmed time
5. Duration of timed override
6. Day of week
7. System model indication: heating, cooling, auto, off, fan auto, fan on
8. Stage (heating or cooling) operation

D. Provide low limit thermostat in supply air to close outside air dampers and stop supply fan.

2.10 OPERATING CONTROLS - VARIABLE VOLUME UNITS

A. Temperature transmitter located in supply air shall signal direct digital logic panel to control supply fan speed, mixing dampers and cooling in sequence. Mixing section shall operate as first stage of cooling and revert to minimum outside air above approximately 75°F as determined by enthalpy of return and outdoor air.

B. Control cooling by cycling compressors, cylinder unloading and hot gas bypass.

C. Control logic shall allow supply air reset under low load or airflow conditions.

D. Provide two-stage morning warm-up thermostat to hold outdoor dampers closed and energize heat until return air temperature reaches set point.

E.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting frame level.

3.3 MANUFACTURER'S FIELD SERVICES

A. Provide initial start-up and shut-down during first year of operation, including routine servicing and check.

3.4 FIELD INSPECTION AND REPORT

A. Provide report, in accordance with Division 01, prepared by manufacturer's representative, stating that systems installed and services provided under this Section are in accordance with manufacturer's recommendations and are properly operating.

END OF SECTION

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SECTION 23 8216
DUCT-MOUNTED AIR COILS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section includes the following types of air coils:

1. Electric duct-mounted reheating coils

1.2 CODES AND STANDARDS (USE LATEST EDITION)

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI)

1. AHRI 410: Forced-Circulation Air-Cooling and Air-Heating Coils

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE 15 Safety Standard for Refrigeration Systems
2. ASHRAE 33: Methods of Testing Forced Circulation Air Cooling and Air Heating Coils
3. ASHRAE 62.1: Ventilation for Acceptable Indoor Air Quality
4. ASHRAE/IESNA 90.1: Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI)

C. ASTM International (ASTM)

1. ASTM A666: Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

D. National Fire Protection Association (NFPA)

1. NFPA 70-2005: National Electrical Code
2. NFPA 90A-2002: Installation of Air Conditioning and Ventilating Systems

E. Underwriters Laboratories (UL)

1. UL 1995: Heating and Cooling Equipment

1.3 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years documented experience.

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. ASHRAE Compliance

1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

1.4 SUBMITTALS

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

1. Rated capacities and pressure drop for each coil
2. Construction details including coil and frame configurations
3. Dimensions of individual components and profiles
4. Material descriptions and coil finishes
5. Rows, connections (sizes and locations), rough-in dimensions

B. Manufacturer's Installation Instructions: Indicate specific installation instructions per the manufacturers of the vAHRIous products and indicate how the system (combination of products) will be assembled.

C. Shop Drawings: Detail equipment assemblies and indicated dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. For electric coils provide wiring diagrams. Detail wiring for power, signal, and control systems and differentiated between manufacturer-installed and field-installed wiring.

D. Coordination Drawings

1. Indicate coil locations and clearance requirements in sheet metal coordination drawings.
2. Provide coordinated reflected ceiling plans drawing to scale and coordinating above-ceiling coil locations and ceiling mounted access panels.

E. Operation and Maintenance Data: Provide for inclusion in operation and maintenance manuals.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site in containers with manufacturer's stamp or label affixed showing indexes of products.

B. Protect coil fins from crushing and bending by leaving in shipping cases until installation and by storing indoors. Do not install damaged coils. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to Owner.

C. Protect coils from entry of dirt and debris with pipe caps or plugs. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

PART 2 - PRODUCTS

2.1 ELECTRIC DUCT-MOUNTED HEATING COILS

A. Acceptable Manufacturers

1. Brasch Manufacturing Co., Inc.
2. Chromalox, Inc., Wiegand Industrial Division; Emerson Electric Company.
3. INDEECO.
4. Thermolec
5. Trane.

B. Comply with UL 1995.

C. Heating Elements

1. Open-Coil: Open-coil resistance wire of 80% nickel and 20% chromium, supported and insulated by floating ceramic bushings recessed into casing openings, and fastened to supporting brackets.
2. Coil shall be rated to provide the required output at the following voltages to account for voltage fluctuations:

a. 215V for a 230 volt service

D. High Temperature Coil: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.

1. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

E. Frames: Galvanized-steel channel frame, minimum 0.0625 inch thick for flanged mounting.

1. Exception: Slip in mounted may be provided where coil is being installed in an existing duct.

F. Control Panel: Unit mounted with disconnecting means and overcurrent protection

a. Magnetic contactor, de-energizing (in lieu of disconnecting)
b. SCR Proportional Control: One master SCR will be provided for full proportional output. SCR power controller shall be furnished with the following:

(1) Failsafe circuitry for shorted or opened input
(2) LED status lights for: power on and system operation

c. Door interlock switch (to break control circuit)
d. Airflow proving switch
e. Control panel shall accept a 0-10V or 4-20mA analog signal from a building automation system controller to adjust SCR output.
f. Pilot lights to indicate:

(1) Low airflow
(2) Heater on

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Support coil sections independent of piping on steel channel or double angle frames and secure to duct. Provide airtight seal between coil and duct or casingStraighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

E. Install access doors on both the inlet and discharge side of all duct-mounted coils.

F. Additional requirements for electric coils:

1. Coordinate with Division 26.
2. Wire electric duct coils in accordance with ANSI/NFPA 70.
3. Perform the following field tests and inspections and prepare test reports:

a. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

SECTION 26 0500
BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes general administrative and procedural requirements for electrical installations, and shall apply to all phases of the work specified, indicated on the drawings, or required to provide for complete installation of electrical systems for this project. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:

1. Submittals
2. Record documents
3. Maintenance manuals
4. Rough-ins
5. Electrical installations
6. Cutting and patching
7. Warranties
8. Temporary
9. Coordination with local utilities

1.2 DEFINITIONS

A. The following definitions shall apply throughout the contract documents:

1. Architect/Engineer: Architect or Engineer
2. Code: All applicable local, state, and national codes - latest edition
3. Contractor: Any contractor performing work required by the Contract Documents
4. Electrical: All electrical work required by the contract documents
5. Furnish: Supply and deliver to the site ready for installation
6. Indicated: Noted, scheduled, or specified
7. Installed: Erected, mounted, secured, connected, and ready for use
8. Mechanical: All mechanical work required by the contract documents
9. Provide: Furnish, install, and connect, complete and ready for use

1.3 CODES AND STANDARDS

A. The electrical system shall comply with the following codes, and all other state, local, municipal, and national bureaus and departments which have authority over this project: anything in these contract documents notwithstanding. This shall not be construed as waiving compliance with any requirements of the plans and specifications that may be in excess of any requirements of any applicable code.

1. National Fire Protection Association (NFPA)
2. American National Standards Institute (ANSI)
3. Occupational Safety and Health Administration (OSHA)
4. Factory Mutual Research Corporation (FM)
5. Underwriters Laboratories Inc. (UL)

B. All systems and components shall be FM approved and listed and labeled by UL.

C. Where there is a conflict between the code and contract documents, the code shall have precedence only when it is more stringent than the contract documents. Items that are allowed by code, but are less stringent than those specified, shall not be substituted.

1.4 QUALITY ASSURANCE

A. Workmanship: The work shall be performed by competent craftsman, skilled in the trade involved, and shall be done in a manner consistent with the NECA National Electrical Installation Standards.

B. Permits: The contractor shall familiarize themselves with all requirements regarding all permits, fees, etc. and shall comply with them. The contractor at his expense shall obtain all permits, licenses, inspections, and arrangements required for the execution of the work. All utilities shall be installed in accordance with the local rules and regulations, and the contractor shall pay all charges.

1. All permits and certificates of inspection shall be turned over to Owner prior to request for final payment.

1.5 SUBMITTALS

A. General: Follow the procedures specified in Division 01 Section 01 3300, "Submittals," and as indicated in this section.

B. Where required by other sections of this specification/project manual, the contractor shall submit shop drawings, product data, or samples to the Architect/Engineer for review through the general contractor. If no general contractor is assigned, the contractor may submit directly to the Architect/Engineer.

C. Unrequired submittals will not be reviewed. Faxed, emailed, or incomplete submittals will not be reviewed.

D. Submittals shall be numbered consecutively and referenced to the section number of the specification section.

E. For shop drawings and product data submittals, the contractor shall submit a minimum of six copies for review to the Engineer through the General Contractor. If no general contractor is assigned the submittals may be sent directly to the Architect/Engineer for review.

F. Additional copies may be required by individual sections of these Specifications.

G. Shop drawings are drawings, diagrams, schedules, and other data specifically prepared for this project by the Contractor, or any manufacturer, supplier, or distributor to illustrate some portion of the work

H. Shop drawing shall be drawn to accurate scale and adequate size to illustrate required details. Maximum sheet size shall be 30" x 42". For each shop drawing sheet larger than 11" x 17", submit one drawing on reproducible media, and one blueline or photocopied print. The Architect/Engineer's action shall be indicated on the reproducible drawing, and that drawing shall be returned to the contractor.

I. Product data are illustrations, standard schedules, performance charts, instruction brochures, diagrams, and other information furnished by the contractor to illustrate a material, product, or system for some portion of the work.

J. Samples are physical examples furnished by the contractor to illustrate materials, equipment, or workmanship, and to establish the standards by which the work will be performed.

K. All submittals shall clearly indicate proposed items, capacities, characteristics, and details in conformance with the contract documents. All equipment items shall be marked with the same item number as used on the drawings or schedules. The manufacturer shall certify capacities, dimensions, and special features required.

L. Submittals shall indicate manufacturer's delivery time for the item after review by the Architect/Engineer.

M. The Architect/Engineer shall review or take other appropriate action upon receipt of the contractor's submittals such as shop drawings, product data and samples, but only to determine conformance with the design concept of the work and the information given in the contract documents.

N. The contractor shall not be relieved of responsibility for any deviation from the requirements of the contract documents by the Architect/Engineer's review of shop drawings, product data, or samples. The Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data, or samples by the Architect/Engineer's review of those drawings.

O. No portion of the work requiring submission of a shop drawing, product data, or sample shall commence until the Architect/Engineer has reviewed the submittal. All such portions of the work shall be in accordance with reviewed submittals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Where recommended by the equipment supplier, deliver equipment in fully enclosed vans after specified environmental conditions have been permanently established in spaces where equipment is to be placed. The products accepted on the site shall be wrapped in factory packing, and shall be inspected for damage prior to acceptance.

C. Store equipment in clean, dry with non-condensing environments that are controlled within manufacturer=s ambient tolerances for non-operating equipment. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

D. Handle equipment carefully to prevent damage, breaking, and scoring. The contractor shall not install damaged units or components; replace with new.

E. Equipment furnished by others. The contractor shall be responsible for receiving, uncrating, inspecting, storing, and installing of Division 26, 27, and 28 equipment listed as furnished by others.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTIES

A. The contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted at the time of final acceptance, or for longer periods of time as specified in those sections of the project manual.

B. The contractor shall repair or replace, at no additional cost to Owner, any item that may become defective within the warranty period.

C. Any manufacturer's warranties concerning any item installed shall be to the benefit of Owner.

D. The contractor agrees not to void or impair or to allow any sub-contractor to void or impair any warranties regarding products or items installed as part of this project.

E. The repair of faulty workmanship shall be considered to be included in the contract.

1.9 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01 Section 01 7700, "Project Closeout." In addition to the requirements specified in Division 01, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

B. The Contractor shall prepare three Operating and Maintenance Manuals for the equipment furnished. Manuals shall be submitted to the Architect/Engineer for review and distribution to Owner within thirty (30) days prior to substantial completion of the project. The Architect/Engineer may reject manuals not meeting the following requirements:

1. Each manual shall be assembled in a three-ring binder with a hard cover and plastic finish. Binders shall not exceed 3" thick. Where more than one binder is required, the manuals shall be separated into logical groupings. Where loose-leaf inserts are used, the sheets shall be reinforced to prevent tearing from continuous usage. Each binder shall have the following information clearly printed on its cover:

   a. Project name and address.
   b. Portion of the work covered by each volume (if more than one volume is in the set). Where more than one volume is required, label each volume as "Volume ___ of ___."
   c. Name, address, and telephone number of the Contractor and all Sub-Contractors including night and emergency numbers.

2. The manual shall include, but shall not be limited to, the following:

   a. A complete index.
   b. Names, Addresses, and Telephone Numbers: The list shall include the manufacturer and local representative who stocks and furnishes repair parts for all items of equipment and shall be typed on a single page in the front of the binder.

c. Start-Up, Operation, and Shutdown Procedures: Provide a written description of procedures for start-up, operation, and shutdown procedures for each electrical item or system. This description shall include switches to operate, buttons to push, etc., in proper sequence, and locations of buttons and switches. The description shall include item references or labels used in the contract documents unless otherwise instructed in advance by Owner.

d. Equipment Accessory Schedule: Upon completion of the work, the Contractor shall furnish Owner with a complete equipment accessory schedule listing each piece of equipment and the related size, type, number required, and the manufacturer of all renewable items.

e. Manufacturer's Operation and Maintenance Manuals and Parts List.

f. Emergency Procedures: Provide a written description of emergency operating procedures or a list of service organizations (including complete business address and telephone numbers) capable of rendering emergency services to the various parts of the system.

g. One copy of all shop drawings and product data, clearly marked for each item furnished using the designation label specified or indicated on the contract documents.

h. All manufacturers' warranty information.

i. Normal Maintenance Schedule: Include a listing of work to be performed at various time intervals (e.g., 30, 90, 180 days, yearly).

1.10 COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of ¼" = 1'-0" or larger, detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

   a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance
   b. Exterior wall and foundation penetrations
   c. Fire-rated wall and floor penetrations
   d. Equipment connections and support details
   e. Sizes and location of required concrete pads and bases

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

1.11 RECORD DOCUMENTS

A. Contractor shall keep an up-to-date set of "as-installed," "red-lined" drawings kept current on a daily basis. Such drawings shall be available to Owner, Engineer, or Owner's representative at the job site at all times.

B. Upon completion of the contract, send to the Architect/Engineer, through the general contractor, one complete set of red-lined drawings showing all deviations.

C. In addition to the requirements specified in Division 01, indicate on the marked up drawings additional information for:

1. Major raceway systems, size and location, for both exterior and interior.
2. Locations of control devices
3. Distribution and branch electrical circuits
4. Switch, fuse, and circuit breaker size and arrangements
5. Equipment locations (exposed and concealed), dimensioned from prominent building lines
6. Approved substitutions, Contract Modifications, and actual equipment and materials installed

1.12 SITE EXAMINATION

A. Visit the site prior to submitting bids, examine the premises, and make a thorough survey of the conditions under which the installation is to be made.

B. The submission of a proposal will be construed as evidence that such an examination has been made, and later claims for labor, equipment, or materials required for difficulties encountered which could have been foreseen had such an examination been made, will not be recognized.

1.13 INTERPRETATION OF THE DOCUMENTS

A. Carefully compare the drawings and specifications, checking measurements and conditions under which this installation is to be made.

B. The interpretations of the intent of the plans shall rest solely with the Architect and the Architect's decision shall be considered final.

C. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Architect/Engineer for clarification. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date. Verbal interpretation or explanation, not issued in the form of an addendum, shall not be considered part of the bidding documents. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.

1.14 ELECTRICAL SERVICE DISRUPTIONS

A. No electrical service disruptions may occur without permission of Owner.

B. Submit a written request for any work electrical outages before taking any operating electrical equipment out of service. Any work involving a task, which requires an electrical service disruption to any part of this facility, shall be closely coordinated with Owner prior to the disruption. All disruptions shall occur at times and of durations acceptable to Owner.

1.15 OVERTIME WORK

A. Construction work shall be done during regular working hours on regular working days unless specifically noted otherwise on the drawings, and as required by Owner. If overtime work, other than specified, is required on the project, it shall be performed as indicated under the special conditions of these contracts.

B. Pricing for required overtime work specified shall be included in the Base Bid.

C. Items requiring overtime work are:

1. Exposing any energized bus
2. Any work above, below, or adjacent to active, operating equipment that must remain in operation during normal hours
3. Replacement or modification to electrical service and distribution to the facility

1.16 SAFETY

A. The contractor shall take all steps necessary to ensure the safety of the occupants, students, Owner's employees, visitors, project related personnel, or any other authorized personnel, as well as their own forces, by adequately protecting any exposed energized cable, equipment, or devices throughout the course of this work.

B. Comply with NFPA 241 for safeguarding during construction and alteration operations. In addition, any openings in fire-rated separations between occupied and unoccupied (or operational and non-operational) areas shall be sealed at the end of each work day with an appropriate fire-rated enclosure or sealant. Do not compromise existing security or fire alarm systems serving the occupied or operational areas.

1.17 INTERFERENCE WITH OCCUPANCY

A. If the existing building is occupied, then the work covered by these documents shall be executed with a minimum of inconvenience to the building occupants.

1.18 DAMAGE TO OTHER WORK

A. This contractor shall be responsible for damage to other work caused by this installation. Patching and repairing of damaged work done by this Division shall be part of the cost of this Division.

1.19 LAYOUT OF WORK

A. Layout work to be installed in coordination with other trades engaged on this project whenever their work is likely to affect the electrical installation. Be fully responsible for all dimensions and conflicts between this work and that of other trades, and make the necessary changes in the work without additional cost to Owner if the work does not comply properly with these requirements.

B. Compare contract documents with those of other trades before proceeding with the installation. Electrical wiring, conduits, or electrical equipment which has been installed without checking for interference and without thorough coordination with other trades shall be moved or relocated without additional expense to Owner.

C. Equipment shall be installed with ample space allowed for removal, repair, or change to the equipment. Ready accessibility to removable parts or equipment and to the wiring shall be provided without moving other equipment which is installed or which is already in place.

1.20 OPERATING TRAINING

A. Complete operating training for each system and item of equipment shall be provided to the Owner's designated personnel. The Operation and Maintenance Manuals must be reviewed and accepted by the Architect/Engineer and provided to the Owner prior to operating training. Training sessions shall consist of two 8-hour periods and shall be scheduled at the convenience of Owner. Training shall include instructions on the following:

1. Start-Up and Shutdown Procedures
2. Emergency Operation
3. Periodic Maintenance
4. Safety

B. In addition to the instructions required above, wherever possible the Contractor shall perform the operation being described in order to fully illustrate system operation.

C. At the completion of training, the Contractor shall turn over to Owner all required keys and special tools for the installed equipment. Each key or tool shall be labeled with its use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise specified, all materials and equipment shall be new, unused, and undamaged. Materials and equipment shall be the current and standard designs of manufacturers regularly engaged in their production.

2.2 MATERIALS AND EQUIPMENT FURNISHED BY OTHERS

A. Where materials and equipment are indicated as furnished by others and installed or connected under this contract, it shall be the Contractor's responsibility to verify installation details prior to proceeding with work.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 21, 22, 23, and 26 for rough-in requirements.

3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.

4. 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 space.
5. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
6. 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.
7. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
8. 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.
9. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 Section 01 7329, "Cutting and Patching." In addition to the requirements specified in Division 01, 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. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

7. 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.

3.4 TEMPORARY LIGHTING POWER, AND FIRE ALARM

A. Work Included

1. Electrical Contractor shall furnish and install temporary lighting, power, and fire alarm devices for this project as required and remove same at the end of the project.
2. Contractor shall install the above mentioned temporary services in a safe and workmanlike manner.
3. Provide temporary lighting and power as required in areas undergoing work during construction. Furnish and install one OSHA-approved pigtail socket with 150W lamp for every 500 square feet of floor space and a minimum one per room. The temporary lighting shall be left in place until permanent lighting is completely operational.
4. Furnish and install power outlets to a total one for every 2,000 square feet or part thereof of floor area. These shall be 15 amp, single phase receptacles for either 110 or 220 V as directed by the General Contractor. Coordinate for additional temporary power requirements with other trades and provide an adequate installation.

B. Contractor to coordinate temporary services with the following:

1. General Contractor
2. Mechanical Contractor
3. Owner/Owner Representative

END OF SECTION

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SECTION 26 0519
CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Scope: The work specified in this section includes, but shall not be limited to, providing labor, materials, equipment, and services necessary for the electrical work as shown on the drawings and as herein specified.

B. Section includes: building wires, cables, and associated connectors, splices, and terminations for wiring systems rated 600 V and less

1.2 DEFINITION

A. THHN: Heat-resistant thermoplastic insulation

B. THWN: Moisture and heat-resistant thermoplastic insulation

C. XHHW: Moisture-resistant thermoset

1.3 CODES AND STANDARDS

A. NEMA WC3: Rubber-insulated wire and cable for the transmission and distribution of electrical energy

B. NEMA WC5: Thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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 NFPA 70.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products and materials properly packaged in factory fabricated containers and mounted on shipping skids.

B. Store products and materials in clean, dry, heated space. Protect from dirt, fumes, water, construction debris, and traffic. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle products and materials carefully to prevent internal damage, breakage, denting, and scoring enclosure finish. Do not install damaged products or materials. Replace and return damaged products or materials to manufacturer.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. The contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion.

B. The contractor shall repair or replace, at no additional cost to Owner, any item that may become defective within the warranty period.

C. The contractor agrees not to void or impair or to allow any sub-contractor to void or impair any warranties regarding products or items installed as part of this project.

D. The repair of faulty workmanship shall be considered to be included in the contract.

1.9 MAINTENANCE

Not Applicable

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify that field measurements are as indicated on the shop drawings and as shown on the drawings

B. Project Location Environment: Furnish and install materials suitable for the altitude, weather, and seismic requirements of the project location.

PART 2 - PRODUCTS

2.1 QUALITY

A. Electrical equipment, devices and associated materials used on this project shall be UL listed and/or labeled.

B. Equipment and devices installed under this division and not constructed with enclosure suited for mounting and protecting all live parts shall be installed in approved metal cabinets.

2.2 WIRE AND CABLE (600 V OR LESS)

A. Acceptable Manufacturers

1. General Cable Corporation (BICC)
2. Southwire
3. Okonite
4. Rome

B. Wire and cable used in this installation shall be copper and shall have 600 V insulation unless otherwise noted.

C. The wires used in this installation shall be run in conduits or approved raceways, unless specifically indicated otherwise.

D. Conductors shall conform to the latest requirements of the Code and meet ICEA Specifications. Submit the name of manufacturer for the Engineer/Architect and Owner's approval, before work is started.

E. Wire and cable shall be delivered to the project in complete coils with the manufacturer's name and approval tag attached thereto, indicating wire size and type of insulation, and be labeled and listed.

F. Unless otherwise noted, conductors for lighting and power circuits shall be #12 AWG minimum size.

G. Wire for control circuits may be #14 AWG.

H. Wire of #8 AWG size and larger shall be stranded. Wire of #10 and smaller shall be solid.

I. All conductors shall be rated 90°C for dry/wet locations.

J. AC branch circuit wiring shall be installed with color-coded conductors throughout the installation as specified in the identification sections of this specification.

2.3 WIRE CONNECTIONS

A. Acceptable Manufacturers

1. Thomas and Betts
2. Hy-Press Corporation
3. FCI Burndy Products

B. All wire connections shall be made by means of solderless connectors.

C. Clean conductor surfaces before installing lugs and connectors. Apply "no-ox" compound.

D. Branch circuit joints or splices for wires #10 and smaller shall be made with 3M brand Scotchlok electrical spring connectors. No splices shall be made in a conductor except at outlet boxes, junction boxes, or in splice boxes.

E. Control wires shall be made by 3M Scotchlok crimp connectors.

F. Use high press long barrel, cast copper, compression connectors for splices and joints for wires #8 and higher.

G. Wires and cables that terminate onto a bus bar shall be made by cast copper, two-hole, long barrel lug, two crimps of fifteen ton compression, hex lugs. Lug bolts shall have lock washers.

H. The phases of all feeders shall be marked at all taps, joints, splices, and near the lugs at each end with permanently colored tapes. Tapes shall be Minnesota Mining #35 vinyl tape or as approved. Tape un-insulated conductors to 150% of insulation rating of conductor.

2.4 FISH WIRE

A. Conduits which are left empty shall contain fish wire of such a gauge required to pull in wire or cable to fill the conduit as determined by Code.

B. Each length of conduit which is to be used for the telephone system shall contain a #l4 gauge nylon fish wire.

C. Terminations of empty conduits shall be properly tagged.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway or XHHW, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN, single conductors in raceway.

C. Feeders Concealed in Concrete, Below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN, single conductors in raceway.

F. Branch Circuits Concealed in Concrete and Below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

G. Underground Feeders and Branch Circuits: Type XHHW, single conductors in raceway.

H. Fire Alarm Circuits: Type THHN-THWN, in raceway or power-limited, fire-protective, signaling circuit cable per manufacturer's direction.

I. Class 1 Control Circuits: Type THHN, in raceway.

J. Class 2 Control Circuits: Type THHN, in raceway or power-limited cable, concealed in building finishes, or power-limited tray cable, in cable tray per manufacturer's direction.

3.2 INSTALLATION

A. All wires and cables shall be installed in conduits unless noted otherwise.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Identify and color-code conductors and cables according to Division 26 Section 26 0505, "Basic Electrical Materials and Methods," Electrical Identification.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.4 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing.

1. After installing conductors and cables and before electrical circuitry has been energized, test for proper installation and polarization.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

END OF SECTION

SECTION 26 0526
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Scope: The work specified in this section includes providing labor, material, equipment, and services necessary for a complete grounding system as shown on the drawings and as herein specified.

B. Grounding Section Includes: The work specified in this section includes, but shall not be limited to, providing grounding of the following:

1. Electrical power systems
2. Electrical metallic raceways
3. Metal enclosures
4. Equipment requiring power

C. Bonding Section Includes: The work specified in this section includes, but shall not be limited to, providing bonding of the following:

1. Interior metallic data equipment systems

1.2 DEFINITIONS

Not Applicable

1.3 CODES AND STANDARDS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. If the referenced publications have been revised prior to Contract award, the latest edition/revision shall be submitted for the referenced document.

C. ASTM International (ASTM)

1. ASTM B 8 – "Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft"
2. ASTM B 33 – (Revised 1985), "Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes"

D. Institute of Electrical and Electronics Engineers (IEEE)

1. ANSI/IEEE 80 – "Guide for Safety in AC Substation Grounding" (copyrighted by IEEE, ANSI approved)
2. ANSI/IEEE 81 – "Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System" (copyrighted by IEEE, ANSI approved)
3. ANSI/IEEE 142 – "Recommended Practice for Grounded of Industrial and Commercial Power Systems" (copyrighted by IEEE, ANSI approved)

E. Insulated Cable Engineers Association (ICEA)

1. ICEA 5-68-516 – "Ethylene Propylene Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy"

F. National Fire Protection Association (NFPA)

1. NFPA 70 – "National Electrical Code (hereinafter referred to as NEC).
2. NFPA 780 – "Installation of Lighting Systems"

G. Underwriters Laboratories, Inc. (UL)

1. UL ECMD – "Electrical Construction Materials Directory"
2. UL 467 – "Grounding and Bonding Equipment"
3. UL 486A – "Wire Connectors and Soldering Lugs for Use with Copper Conductors, Seventh Edition"

H. American National Standards Institute, Electronic Industries Alliance/Telecommunications Industry Alliance (ANSI/EIA/TIA), ANSI/EIA/TIA-607 Grounding and Bonding.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms shall be engaged in manufacture of grounding and bonding products, of types, sizes required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes, and bonding jumpers, and whose products have been in satisfactory use in similar service for not less than five years.

B. Installer's Qualifications: Firms shall have at least five years of successful installation experience with projects utilizing grounding systems similar to that required for this Project.

C. Compliance: Comply with applicable local electrical code requirements, NEC, ANSI/IEEE 142, and applicable UL requirements.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data showing material proposed. Product data shall include, but shall not be limited to, the following:

1. Conductors
2. Cables
3. Connectors

B. Shop Drawings: Submit complete shop drawings as required to determine acceptability. Shop drawings shall consist of a complete list of materials, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instruction. Shop drawings shall include, but shall not be limited to, the following:

1. Special fabricated components, which are not a manufactured standard product.

C. Proof of Compliance: Where materials or equipment are specified to comply with requirements of UL, proof of such compliance shall be submitted.

D. Test Reports: Submit ground testing test report as specified.

E. Operation and Maintenance Manuals: Prepare and deliver complete operating and maintenance manuals. Provide information pertinent to the equipment for preventive maintenance and for replacement of expendable components. Manuals shall include the items listed below and other information recommended by the manufacturer:

1. Cables
2. Complete list of parts with reordering numbers
3. Electrical characteristics of components
4. Recommended spare parts list
5. Complete set of shop drawings

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Materials and components shall be properly packaged, stored, and handled to prevent damage or breakage.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. The contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted at the time of final acceptance, or for longer periods of time as specified in those sections of the project manual.

B. The contractor shall repair or replace, at no additional cost to Owner, any item that may become defective within the warranty period.

C. The repair of faulty workmanship shall be considered to be included in the contract.

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work, include, but shall not be limited to, the following:

1. Adalet-PLM Division; Scott Fetzer Co.
2. Burndy Corporation
3. Cadweld Division; Erico Products, Inc.
4. Crouse-Hinds Division; Cooper Industries
5. Joslyn Corporation
6. OZ Gedney Division; General Signal Corp.
7. Thomas and Betts Corp.
8. Eritech; Erico Products, Inc.

2.2 CONDUCTORS

A. General: Grounding and bonding conductors shall be bare and insulated copper as shown on the drawings or required by other sections of this specification.

B. Conductivity: Copper conductors shall have a conductivity of not less than 98 percent at 75 degrees C. Conductor resistance values shall be in accordance with the value in ICEA S-68-516.

C. Cable Sizes: Cable sizes shall be as shown on the drawings or as required by this specification.

D. Insulation: Insulated grounding and bonding conductors shall have an insulation equal to the current carrying conductors.

2.3 CONNECTORS

A. Metal Pipe Connectors: Connectors shall be copper alloy, U-bold type.

B. Ground Bushings: Bushings shall be malleable iron, zinc plated, insulated throat with screw type wire connector.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which the work is to be installed, and notify the Architect/Engineer in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Coordinate with other work to ensure that installation is not vulnerable to physical damage.

3.3 APPLICATION

A. General: The entire electrical system and building structure shall be grounded. The following items of equipment, appurtenances, and as required by Article 250 of NEC, shall be grounded:

1. Electrical equipment, and enclosures
2. Conduits and raceways
3. Neutral and ground conductors
4. Switches and panels
5. Motor frames, control cabinets, and lighting fixtures

B. All metallic conduits, supports, cabinets, and all the other electrical equipment shall be permanently and effectively grounded. All grounded shall be in accordance with the applicable code, and shall meet the approval of the local Inspection Department.

C. All metallic raceways shall be mechanically and electrically continuous. Where non-conductive raceways are installed, provided separated equipment grounding conductors bonded to pull and/or junction boxes at each end of each conduit run.

D. Furnish and install a separate equipment grounding wire with each branch circuit conduit, routed with the phase and neutral wires, NEVER in a separate conduit.

E. Equipment grounding wire to be routed in conduit along the phase and neutral wires (NEVER in separate conduit) per code and the Illinois Department of Public Health (IDPH) requirements.

F. Installation of the equipotential grounding system shall be as detailed in Article #18-27-517 (Chicago Electrical Code), in NFPA-70 Articles #517 and 660, and NFPA #99. The required equipment and associated panels are indicated on the electrical design drawings.

G. Connectors: Provide mechanical connections for the following:

1. Cable-to-pipe
2. Cable-to-ground bus or as otherwise noted on the drawings

H. Bonding Jumpers: Bonding jumpers shall be installed where continuity of piping or metal must be maintained or as required by NEC.

3.4 INSTALLATION

A. Install grounding systems as indicated, in accordance with equipment manufacturer's written instructions and with recognized practices. Comply with applicable requirements of UL 467, UL 486A, NFPA 78 ANSI/IEEE 80, and applicable NEMA standards, to ensure that products fulfill requirements.

B. Connectors

1. Provide mechanicals connections as specified.
2. Remove non-conductive coatings such as paint, lacquer, and enamel on surfaces of equipment to be grounded.
3. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 468A to assure permanent and effective grounding.
4. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory-applied protective coatings have been destroyed, which are subjected to corrosive action.
5. No connections below grade shall be covered before inspection by the Architect/Engineer.

C. Bonding Jumpers: Install on water meters and where expansion joints or dielectric unions are used.

D. Ground Bushings: Where a conduit enters a metal enclosure without a ground bus, a ground bushing shall be provided to terminate ground conductor.

END OF SECTION

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SECTION 26 0533
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes raceways, fittings, pull boxes, outlet boxes, floor fittings, surface, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing

B. RMC: Rigid metal conduit (heavy wall steel)

C. FMC: Flexible metal conduit

D. IMC: Intermediate metal conduit

E. LFMC: Liquidtight flexible metal conduit

F. RNC-40: Rigid non-metallic conduit, schedule 40 PVC

G. RNC-80: Rigid non-metallic conduit schedule 80 PVC

H. Fittings: Conduit connection or coupling

I. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only

J. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.

K. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and floors.

L. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.

M. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.

N. Slab: Horizontal pour of concrete used for the purposes of a floor or sub-floor

1.3 CODES AND STANDARDS

A. American National Standards Institute (ANSI)

1. ANSI C80.1 – Rigid Steel Conduit, Zinc-Coated
2. ANSI C80.3 – Electrical Metallic Tubing, Zinc-Coated and Fittings
3. ANSI C80.4 – Fittings for Rigid Metal Conduit
4. ANSI C80.6 – Intermediate Metal Conduit, Zinc-Coated
5. ANSI/NEMA OS-1 – Sheet Steel Outlet Boxes, Device Box Covers and Bottom Supports
6. ANSI/NEMA OS-2 – Non-Metallic Outlet Boxes, Device Boxes, and Box Support

B. Federal Specifications (FS)

1. WC-586 – Conduit Outlet Boxes, Bodies, and Entrance Caps, Electrical Cast Metal
2. WC-408 – Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall [EMT] Type)
3. WC-1904A – PVC Rigid Non-Metallic Conduit
4. WC-563A – Electrical Metallic Tubing
5. WC-566 – Specification for Flexible Metal Conduit
6. WC-581E – Specification for Galvanized Rigid Conduit

C. NECA "Standard of Installation"

D. National Electrical Manufacturers Association (NEMA)

1. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
2. RN 2 – Packaging of master bundles for Steel Rigid Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing
3. TC 2 – Rigid Non-Metallic Conduit, PVC Schedule 40 (EPC-40) and Schedule 80 (EPC-80) PVC
4. TC 3 – Rigid Non Metallic Conduit and electrical Non-Metallic Tubing Fittings
5. TC 6 – PVC and ABS Plastics Utilities Duct for Underground Installation
6. TC-8 – Extra-Strength PVC Plastic Utilities Duct for Underground Installation
7. TC-9 – PVC and ABS Plastic Utilities Duct and Fittings for Underground Installation
8. TC 10 – PVC and ABS Plastic Communications Duct and Fittings for Underground Installation
9. TC 13 – Electrical Non-Metallic Tubing
10. TC 14 – Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings
11. TC 18 – Packaging of Master Bundles for EPC 40 (Polyvinyl Chloride) Conduit
12. NEMA 250 – Enclosures for Electrical Equipment (1,000 volts maximum)

E. National Fire Protection Association (NFPA)

1. ANSI/NFPA 70 – National Electrical Code

F. Underwriters Laboratories (UL): Applicable Listings

1. UL 1 – Flexible Metal Conduit
2. UL 6 – Rigid Metal Conduit
3. UL 360 – Liquid Tight Flexible Steel Conduit
4. UL 514-B – Fittings for Conduit and Outlet Boxes
5. UL 651-A – Type EB and a PVC Conduit and HDPE Conduit
6. UL 797 – Electrical Metal Tubing
7. UL 1242 – Intermediate Metal Conduit

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.

B. Comply with NFPA 70.

C. Contractor's Quality Assurance Responsibilities: The Contractor shall be solely responsible for quality control of the work.

D. Manufacturer's Qualifications: Firms shall be engaged in the manufacture of products and materials of types and sizes required, and whose products have been in satisfactory use in similar service for not less than five years.

E. Contractor's Qualifications: Firms shall have at least five years of successful installation experience with projects utilizing products and materials similar to that required for this Project.

F. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and Municipal authorities having jurisdiction. Obtain approvals from such authorities.

G. Installation: Comply with NECA National Electrical Installation standards for electrical construction methods.

1.5 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, enclosures, cabinets, floor boxes, pull boxes, and outlet boxes.

C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

1. Ceiling suspension assembly members
2. Method of attaching hangers to building structure
3. Size and location of initial access modules for acoustical tile
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings

D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures, cabinets, accessories, and components will withstand seismic forces as listed for the zone of work that construction occurs. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products and materials properly packaged in factory fabricated containers and mounted on shipping skids.

B. Store products and materials in clean, dry, heated space. Protect from dirt, fumes, water, construction debris, and traffic. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle products and materials carefully to prevent internal damage, breakage, denting, and scoring enclosure finish. Do not install damaged products or materials. Replace and return damaged products or materials to manufacturer.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. The contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion.

B. The contractor shall repair or replace, at no additional cost to Owner, any item that may become defective within the warranty period.

C. The contractor aggress not to void or impair or to allow any sub-contractor to void or impair any warranties regarding products or items installed as part of this project.

D. The repair of faulty workmanship shall be considered to be included in the contract.

1.9 MAINTENANCE

Not Applicable

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify that field measurements are as indicated on the shop drawings and as shown on the drawings.

B. Project Location Environment: Furnish and install materials suitable for the altitude, weather, and seismic requirements of the project location.

1.11 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: (Heavy Wall), hot-dipped galvanized with threaded fittings

B. IMC: zinc-coated steel, with threaded fittings

C. Plastic-Coated Steel Conduit: NEMA RN 1, with threaded fittings

D. Plastic-Coated IMC: NEMA RN 1, with threaded fittings

E. EMT: zinc-coated steel, with insulated throat compression fittings (no set screw)

F. FMC: Zinc-coated steel, with insulated throat squeeze-type connectors

G. LFMC: Zinc-coated steel with sunlight-resistant and mineral oil-resistant PVC jacket

H. Fittings: compatible with conduit and tubing materials

2.2 NONMETALLIC CONDUIT AND TUBING

A. RNC: Schedule 40 and Schedule 80 PVC

B. RNC Fittings: match to conduit or tubing type and material

2.3 METAL WIREWAYS

A. Manufacturers:

1. Hoffman
2. Square D
3. Approved Equal

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA rating as indicated on the electrical drawings

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70

E. Wireway Covers: Hinged type, screw-cover type, or flanged-and-gasketed type as indicated on the electrical drawings

F. Finish: Manufacturer's standard enamel finish

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Available manufacturers:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Appleton Electric Company
3. Erickson Electrical Equipment Co.
4. Hoffman
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal
7. RACO; Division of Hubbell, Inc.
8. Spring City Electrical Manufacturing Co.
9. Thomas & Betts Corporation
10. Walker Systems, Inc.; Wiremold Company (The)
11. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

B. Construction:

1. Sheet Metal Outlet and Device Boxes: Galvanized Steel
2. Cast-Metal Outlet and Device Boxes: Type FD, with gasketed cover
3. Floor Boxes: Cast metal, fully adjustable, rectangular
4. Small Sheet Metal Pull and Junction Boxes: Screwcover or hinged as shown on the electrical drawing
5. Cast-Metal Pull and Junction Boxes: Cast aluminum with gasketed cover
6. Cabinets: Galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged

door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.5 PULL BOXES

A. Provide pull boxes as shown on the plans and where necessary to meet code and specification requirements for proper installation of associated wiring systems.

B. Pull boxes shall be sized in accordance with the National Electric Code, NFPA 70.

C. Boxes indicated on the plans are not intended to be drawn to scale.

D. Conduit runs of more than 100 feet or with more than the equivalent of three 90 degree bends shall have suitable pull boxes installed in convenient intermediate locations. Such pull boxes shall be shown on the shop drawings and construction record drawings.

E. Pull boxes over 100 cubic inches shall be supported independently of the conduits.

F. Pull boxes shall be accessible after completion of installation.

2.6 OUTLET BOXES

A. Boxes for Suspended or Bracket Mounted Lighting Fixtures: Ceiling outlets and bracket outlets which are to support lighting fixtures shall be equipped with a ⅜" malleable iron fixture stud securely fastened into the outlet box.

B. Flush Mounted Boxes (in plaster, drywall, poured concrete, smooth tile):

1. Outlet boxes for duplex receptacles, single and two-gang toggle switches, shall be a minimum of 4" square by 1½" deep.
2. Outlet boxes for other devices installed under similar conditions shall be a minimum of 4" square 1½" deep.
3. Where more than two conduits enter an outlet box, a 2 ⅛" deep box shall be used, except in columns.
4. Where three or more gangs of devices are required, solid gang boxes a minimum of 4 ½" high by 1⅝" deep shall be used.
5. Provide suitable plaster rings as required.
6. Provide minimum of ½" deep tile covers as required.

C. Flush Mounted Data/Telephone or Clock Outlet Boxes: Outlet boxes which are to be used as data/telephone outlets or clock outlets shall conform to the requirements of switch and receptacle outlets, employing a single gang opening in the plaster cover, unless noted otherwise on the electrical drawings.

D. Capped Outlet Boxes: Outlet boxes which are indicated as capped outlet boxes shall employ flat metal cover plates, fastened to the outlet box with screws.

E. Surface Mounted Outlet Boxes: Where outlet boxes are to be installed exposed on ceiling or wall surfaces, the boxes shall be specifically designed for such a type of installation and shall be square or rectangular as required. Device plates shall match the contour of the boxes and shall be of the type manufactured for these particular type boxes. In finished areas, all boxes shall be flush mounted unless specifically noted otherwise.

F. Suspended Ceiling Outlet Boxes:

1. Where outlet boxes are installed in suspended ceiling cavities for the purpose of splicing fixture wire, branch circuit conductors and for connecting flexible metallic conduit between this box and the lighting fixtures, such boxes shall be of

the size required by code requirements pertaining to the number of conductors entering and leaving the box. Minimum box size shall be 4" square by 1½" deep.

2. Each box shall be secured to the ceiling channel irons or building structure and shall have its opening facing the nearest recessed lighting fixture.
3. All boxes shall have covers or device plates as required.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: Rigid steel or IMC
2. Concealed: Rigid steel or IMC
3. Underground, concrete encased beyond 5'0" of building: RNC-40
4. Underground, non-concrete encased beyond 5'0" of building: RNC-80
5. Connection to Vibrating Equipment (including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4

B. Indoors:

1. Exposed Dry Locations: EMT
2. Concealed in Interior Partition: EMT
3. Connection to Vibrating Equipment (including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations
4. Damp or Wet Locations: RMC or IMC
5. Concealed in Concrete or Block Walls: RMC or IMC
6. Mechanical Rooms and Penthouses: RMC or IMC
7. Imbedded in Concrete Slabs: RMC or IMC
8. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
    a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel

C. Minimum Raceway Size: ¾" trade size (DN 21).

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

3.2 INSTALLATION

A. Keep raceways at least 6" (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26 Section 26 0505, "Basic Electrical Materials and Methods."

D. Install temporary caps to prevent foreign matter from entering raceways.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2" (50 mm) of concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1" trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J. Join raceways with fittings designed and approved for that purpose and make joints tight.

K. Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength.

M. Telephone and Signal System Raceways, 2" Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a

flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces
2. Where otherwise required by NFPA 70

O. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6" (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

P. Flexible Connections: Use maximum of 72" (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

Q. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

R. Bushings

1. Provide bushings wherever IMC, RMC, or EMT conduit is terminated, including stub-outs, and locations not provided with connection fittings or boxes.
2. Insulated Bushings
    a. Provide insulated bushings or connections for IMC, RMC, or EMT conduit terminations.
    b. Insulated bushings shall be OZ/Gedney Co., Type PBP for rigid conduit or Type "SBT" for EMT, or approved equal.
3. Grounded Type Insulated Bushings
    a. Provide grounded type insulated bushings for all electric service and distribution feeder conduits, including stub-outs.
    b. Bushings shall be properly grounded and/or bonded.
    c. Ground type insulated bushings shall be OZ/Gedney Co. Type "BLG" or approved equal.
4. Insulating Bushings
    a. Provide insulating bushings where cables pass through walls of metal enclosures. Bushings shall be OZ/Gedney Co. Type "BBL" or "ABB" or approved equal.
    b. Insulated bushings shall be used at ends of threaded rigid conduits and threaded fittings. Provide double locknuts when terminated in enclosure.
    c. Bushings shall be OZ/Gedney Co. Type "A" or approved equal.

S. Rigid Conduit Fittings and Couplings

1. Running threads shall not be used on conduit for connection at couplings.
2. IMC and RMC conduits shall be joined by approved threaded couplings.
    a. Threadless couplings and connectors are not acceptable.
    b. Set screw couplings are not acceptable.
    c. Split couplings are not acceptable.

3. Joints in conduit which are installed under or in the floor slab, or in exterior walls shall be made watertight by using T&B Kopr-shield thread compound on each joint.

T. Electric Metallic Tubing (EMT) Conduit Fittings and Couplings

1. Only insulated throat type compression fittings shall be used.
2. Only compression-type fittings shall be used, set screw fittings and couplings are not acceptable.

U. Couplings and unions shall be mechanically strong and shall be so installed to make a continuous bond between the conduits connected.

3.3 PULLING COMPOUND

A. If it is desired to use a pulling compound on wire and cable, first obtain the approval of the Engineer/Architect before employing such compounds. Compound shall be UL listed and compatible with conductor insulation covering.

B. Conduits shall be swabbed until moisture and dirt are removed and before wires are pulled or cables are installed.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.5 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

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SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Scope: The work specified in this section includes, but shall not be limited to, providing labor, materials, equipment, and services necessary for the electrical work shown on the drawings and as herein specified.

B. Section includes: receptacles, dimmer switches, toggle switches, and finish plates.

1.2 DEFINITIONS

A. GFI: Ground-fault circuit interrupter.

1.3 CODES AND STANDARDS

A. FS W-C-596 – Electrical Power Connector, Plug, Receptacle, and Cable Outlet

B. FS W-S-896 – Switch, Toggle

C. NEMA WD 1 – General Color Requirements for Wiring Devices

D. NEMA WD 6 – Wiring Devices – Dimensional Requirements

E. UL 1472 – Solid State Dimming Controls

F. UL 943 – Standard for Ground Fault Circuit Interrupters

G. UL 498 – Standard for Attachment Plugs and Receptacles

H. UL 20 – Standard for General Use Snap Switches

I. DSCC W-C-896F – General Specification for Electrical Power Connector

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.

B. Comply with NFPA 70.

1.5 SUBMITTALS

A. Product Data: For each product specified

B. Shop Drawings: Legends for receptacles and switch plates

C. Samples: For devices and device plates for color selection and evaluation of technical features

D. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 01

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products and materials properly packaged in factory fabricated containers and mounted on shipping skids.

B. Store products and materials in clean, dry, heated space. Protect from dirt, fumes, water, construction debris, and traffic. Where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle products and materials carefully to prevent internal damage, breakage, denting, and scoring enclosure finish. Do not install damaged products or materials. Replace and return damaged products or materials to manufacturer.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. The contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted at the time of final acceptance, or for longer periods of time as specified in those sections of the project manual.

B. The contractor shall repair or replace, at no additional cost to Owner, any item that may become defective within the warranty period.

C. Any manufacturer's warranties concerning any item installed shall be to the benefit of Owner.

D. The contractor agrees not to void or impair or to allow any sub-contractor to void or impair any warranties regarding products or items installed as part of this project.

E. The repair of faulty workmanship shall be considered to be included in the contract.

1.9 MAINTENANCE

Not Applicable

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify that field measurements are as indicated on the shop drawings and as shown on the drawings.

B. Project Location Environment. Furnish and install materials suitable for the altitude, weather, and seismic requirements of the project location.

1.11 COORDINATION

A. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

B. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

C. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 SWITCHES AND RECEPTACLES

A. Provide the various switches and receptacles shown on the plans.

B. In general, the color of all devices shall be brown or ivory. UPS protected receptacles shall have an orange nylon face, emergency system receptacles shall have a red nylon face, and surge suppression shall have a blue nylon face.

C. All devices shall be Underwriters' Laboratories listed, Federal specification listed, heavy-duty type. Receptacles shall be grounding type.

D. Devices shall be manufactured by the following:

1. Duplex receptacles, 20 Ampere, 125 Volt

a. Standard duplex [Brown or Ivory]

(1) P&S/Legrand #5362
(2) Hubbell #HBL5352
(3) Leviton #5362
(4) Cooper #5362

b. Isolated Ground [Orange]

(1) P&S/Legrand #IG6300
(2) Hubbell 5352IG
(3) Leviton 8300IG
(4) Cooper #IG8300RN

c. Ground Fault Circuit Interrupter (GFI) [Brown or Ivory = Normal; Red = Emergency]

(1) P&S/Legrand #1591 (Hospital Grade # 2091-HG)
(2) Hubbell #GF5362 (Hospital Grade # HFG 8300)
(3) Leviton #6899-HG (Hospital Grade #6898-HG)
(4) Cooper #GF20 (Hospital Grade #HGF20)

2. Toggle switches 20A, 120-277V [Brown or Ivory = Normal; Red = Emergency]

a. Single Pole

(1) Hubbell 1221
(2) P&S/Legrand #20AC1
(3) Leviton #1221
(4) Cooper #2221

b. Three Way:

(1) Hubbell 1223
(2) P&S/Legrand #20AC3
(3) Leviton #1223
(4) Cooper #2223

c. Four Way: HBL1224

(1) Hubbell 1224
(2) P&S/Legrand #20AC4
(3) Leviton #1224
(4) Cooper #2224V

2.2 DEVICE PLATES

A. Device plates shall be of same manufacture as device, and shall be flat surface type.

B. Device plates in mechanical and electrical equipment rooms and unfinished areas shall be cadmium-plated steel.

C. Device plates in finished areas shall be stainless steel Type 302. [Nylon, brown or ivory, to match device; or red emergency system.]

D. All multi-gang plates shall be one piece.

E. Plates for outlet boxes shall contain a label for identifying circuit number and panel source. See specification Division 26 Section 26 0505, "Electrical Identification," for additional information.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

F. Protect devices and assemblies during painting.

G. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."

B. Comply with Division 26 Section 26 0505, "Basic Electrical Materials and Methods."

1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
2. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

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.

3.4 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.

B. Check TVSS receptacle indicating lights for normal indication.

C. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

D. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

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SECTION 26 2813
FUSES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes the following:

1. Cartridge fuses, rated 600V and less, for use in switches, panelboards, switchboards, controllers, and motor control centers; and spare fuse cabinets.
2. Cable limiters for use on service entrance applications where multiple cables per phase are installed.

1.2 DEFINITIONS

A. Fuse: A safety device that protects an electric circuit from excessive current, consisting of or containing a metal element that melts when current exceeds a specific amperage, thereby opening the circuit.

1.3 CODES AND STANDARDS

A. UL 198C: High-Interrupting Capacity Fuses; Current Limiting Types

B. UL 198E: Class R Fuses

C. FS W-F-870: Fuseholders (For Plug and Enclosed Cartridge Fuses)

D. NEMA FU 1: Low Voltage Cartridge Fuses

E. NFPA 70: National Electrical Code

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide fuses and cable limiters from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with NEMA FU 1
2. Comply with NFPA 70

1.5 SUBMITTALS

A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

1.6 DELIVERY AND STORAGE

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Where recommended by the equipment supplier, deliver equipment in fully enclosed vans after specified environmental conditions have been permanently established in spaces where equipment is to be placed. The products accepted on the site shall be wrapped in factory packing and shall be inspected for damage prior to acceptance.

C. Store equipment in clean, dry with non-condensing environments that are controlled within manufacturer's ambient tolerances for non-operating equipment. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

D. Handle equipment carefully to prevent damage, breaking, and scoring. The contractor shall not install damaged units or components: replace with new.

1.7 SPARE PARTS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Quantity equal to 10% of each fuse type and size, but not fewer than three of each type and size
2. Provide two (2) fuse pullers to Owner

1.8 WARRANTY

A. The contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted at the time of final acceptance, or for longer periods of time as specified in those sections of the project manual.

B. The contractor shall repair or replace, at no additional cost to Owner, any item that may become defective within the warranty period.

1.9 MAINTENANCE

A. Replace failed fuses during period of construction. Replacement of blown fuses after substantial completion will be the responsibility of this contractor, thru the warranty period, using the Owner's spare fuses.

1.10 COORDINATION

A. Coordinate fuse ratings with HVAC, refrigeration equipment, and motor nameplate ratings for maximum fuse size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Fuses, 30 through 600 amperes:
   a. Bussman #LPS-RK-SP
   b. Ferraz Shawmut #AMP TRAP 2000 RK1
   c. Little Fuse Power Gard #LLSRK-1D Series

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install cable limiter devices on both ends (at load side of service transformer and at line side of main switch) of incoming electrical service cables where multiple-cables-per-phase systems are installed.

3.3 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION

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SECTION 26 2816
SAFETY AND DISCONNECT SWITCHES/ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes the following:

1. Equipment disconnects
2. Motor-circuit disconnects
3. Molded case circuit breaker in an individual enclosure

1.2 DEFINITIONS

Not Applicable

1.3 CODES AND STANDARDS

A. NEMA KS-1 – Enclosed Switches

B. NFPA 70 (NEC)

1.4 QUALITY ASSURANCE

A. Comply with codes for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

C. Single-Source Responsibility: All enclosed switches and circuit breakers shall be the product of a single manufacturer.

1.5 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product data for switches and accessories specified in this Section.

C. Descriptive data and time-current curves for protective devices and let-through current curves for those devices with current-limiting characteristics. Include coordination charts and tables, and related data.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Where recommended by the equipment supplier, deliver equipment in fully enclosed vans after specified environmental conditions have been permanently established in spaces where equipment is to be placed. The products accepted on the site shall be wrapped in factory packing and shall be inspected for damage prior to acceptance.

C. Store equipment in clean, dry with non-condensing environments that are controlled within manufacturer's ambient tolerances for non-operating equipment. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

D. Handle equipment carefully to prevent damage, breaking, and scoring. The contractor shall not install damaged units or components; replace with new.

E. Equipment furnished by others. The contractor shall be responsible for receiving, uncrating, inspecting, storing, and installing of Division 26 equipment listed as furnished by others.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. Motor and circuit disconnects and breakers shall be warranted for a minimum period of one year after project completion, or longer if manufacturer's warranty allows.

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide enclosed switches and circuit breakers by one of the following:

1. Safety Switches:
   a. Square D
2. Circuit Breakers:
   a. Square D

2.2 GENERAL

A. Disconnect and Safety Disconnect Switches:

1. General: Provide heavy duty surface-mounted safety switches for motors and equipment unless otherwise indicated, of types, sizes, and electrical characteristics as indicated on the electrical drawings and equipment schedules.
2. Switch Interiors: Switches shall have switch blades which shall be fully visible in the off position when the enclosure door is open. Current carrying parts shall be plated copper and switch contacts shall be silver-tungsten. Lugs shall be removable and shall be UL-listed for 75 degrees C, copper wire.
3. Switch Operator: Switches shall be quick-made, quick-break type. The operating handle shall be an integral part of the enclosure base and shall be padlockable in the off position. The handle position shall indicate whether the switch is in the on or off position.
4. Interlock Contacts: Provide two Form C auxiliary, 10 ampere, 300V rated contacts. The contacts shall provide for two normally open and two normally closed contacts for switch open or closed position.

B. Circuit Breakers:

1. All circuit breakers shall comply with NEMA ABI and FSW-C-375.
2. Circuit breakers shall be securely bolted to the enclosure and be flush with the box assembly.
3. Circuit breakers shall have over center toggle mechanism with quick-make, quick break action, common trip for all pole positions, and a handle position indicator with breaker rating imprinted in a location easily verified without removing the box cover.
4. Circuit breakers for heating, air conditioning, refrigeration and all motor loads shall be HCAR rated.
5. Circuit breaker size(s) shall be listed on the electrical plan drawings or equipment schedule.

2.3 ENCLOSURES

A. NEMA 1: Provide NEMA 1 general purpose enclosures for indoor installation unless otherwise indicated on the drawings. Enclosure covers shall be attached with pin type hinges. Enclosures shall have a gray baked enamel finish, electrodeposited on clean, phosphatized steel.

B. NEMA 3R: Provide NEMA 3R general purpose enclosures for outdoor installation unless otherwise indicated on the drawings. Enclosure cover shall be attached with pin type hinges and shall be securable in the open position. NEMA 3R enclosures shall be manufactured from galvanized steel. Enclosures shall have a gray baked enamel finish, electrodeposited on cleaned, phosphatized steel. Provide rainproof bolt-on hubs.

2.4 RATINGS

A. General: Provide heavy duty safety switches and circuit breakers with ampere rating as shown on the drawings.

B. Horsepower-Rated: Safety switches shall be horsepower-rated for 250, 480, and 600V, AC and DC, and shall be rated for the motor driven loads supplied by the switch.

C. Short Circuit Rating: Safety switches with Class RK1 or Class L fuses shall have a UL short circuit rating of 100,000 amperes RMS symmetrical minimum.

D. Circuit breakers shall have a UL short circuit rating of 65,000 amperes RMS symmetrical minimum.

2.5 FUSIBLE SWITCHES

A. Provide fusible disconnect switches as shown on the drawings.

B. Fusible disconnects rated 30 through 600 amperes shall have Class RK1 fuse clips. Refer to Division 26, Section 26 2813, "Fuses," for acceptable fuse manufacturers.

C. Disconnects rated 800 through 1200 amperes shall have Class L fuse clips. Refer to Division 26, Section 26 2813, "Fuses," for acceptable fuse manufacturers.

2.6 IDENTIFICATION

A. Each disconnect switch, circuit breaker, and shunt trip control panel shall have an engraved, laminated bakelite nameplate attached to the outside of the enclosure. The nameplate shall include the switch or breaker designation and the equipment it serves. Attach the nameplate by screws or rivets. See Division 26, Section 26 0505, "Basic Electrical Materials and Methods."

2.7 ELECTRICAL INTERLOCKS

A. Provide electrical interlock switches on disconnects as specified herein. The interlock switches shall open prior the opening of the power switch and close only after the power switch has been enclosed. Provide two sets normally open (NO) and normally closed (NC) switches for each disconnect.

B. Provide the necessary control wiring to the interlock switch to disconnect the control circuit from the motor controller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosed switches, breakers, and control panels in locations as indicated, according to manufacturer's written instructions. Comply with all applicable requirements of electrical installations and for the seismic zone of this project.

B. Install enclosures level and plumb.

C. Install wiring between enclosed switches and control/indication devices as required.

D. Connect switches, breakers, panels, enclosures, and components to wiring system and to equipment ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

E. Mounting: Mount enclosures on building structures adjacent to equipment unless otherwise noted. Enclosures shall not be mounted on equipment served, unless it is a part of a preassembled control panel. If building structure is not adjacent to the equipment, provide a separate unistrut rack with supports, clear of equipment, for mounting of switch and breaker enclosure. Conduits shall not be used for the support means.

F. Location:

1. Disconnects and breaker enclosures shall be readily accessible and shall not interfere with removal of equipment parts or with standard maintenance. Disconnects and breaker enclosures shall be installed with their top at 5½ feet above the floor unless otherwise noted on the drawings.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will employ and pay an independent testing agency to perform specified field quality-control testing.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

3.4 FLASH PROTECTION WARNING SIGNS

A. The electrical contractor shall provide all flash protection warning signs as required by the NEC Article 100.16. Warning signs shall conform to the requirements of NFPA 70E.

1. All electrical equipment such as switchboards, panelboards, control panels, meter socket enclosures, and motor control centers, that are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electrical hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.\
2. All warning signs MUST be installed before owner's personnel are trained on the use of the equipment.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules for start-up and shutdown, troubleshooting, servicing, and preventive maintenance.

B. Review data in Division 01 Section 01 7823, "Operating and Maintenance Manual." Refer to Division 01 Section 01 7700, "Project Closeout."

C. Schedule training with Owner through the Architect with at least 7 days' advance notice.

END OF SECTION

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SECTION 26 2913
MOTOR STARTERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Scope: The work specified in this section includes, but shall not be limited to, providing labor, material, equipment and services necessary for motor starters as shown on the drawings and as herein specified. This section shall cover motor starters provided by Division 26 or equipment manufacturer's control panels.

B. Section Includes: The work specified in this section includes, but shall not be limited to, providing the following:

1. Full Voltage Manual starters

1.2 DEFINITIONS

A. Motor Starter: An electrically operated switch that uses magnetic induction to provide the startup current for a motor

B. CPT: Control power transformer

C. MCCB: Molded-case circuit breaker

D. MCP: Motor circuit protector

E. N.C.: Normally closed

F. N.O.: Normally open

G. OCPD: Overcurrent protective device

H. SCR: Silicon-controlled rectifier

1.3 CODES AND STANDARDS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1.	IEEE 74	"Test Code for Industrial Control (600 Volts or Less)"
2.	ANSI/IEEE 518	"Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources" (copyrighted by IEEE, ANSI approved)

D. National Electrical Manufacturers Association (NEMA):

1.	NEMA 250	"Enclosures for Electrical Equipment (1,000 Volts Maximum)" (Copyrighted by NEMA, ANSI approved)
2.	NEMA ICS 1	"General Standards for Industrial Controls and Systems" (Copyrighted by NEMA, ANSI approved)
3.	NEMA ICS 2	"Industrial Control Devices, Controllers and Assemblies" (Copyrighted by NEMA, ANSI approved)
4.	NEMA ICS 3	"Industrial Systems" (Copyrighted by NEMA, ANSI approved)

5. NEMA ICS 4 "Terminal Blocks for Industrial Use" (Copyrighted by NEMA, ANSI approved)
6. NEMA ICS 6 "Enclosures for Industrial Control and Systems" (Copyrighted by NEMA, ANSI approved)

E. National Fire Protection Association (NFPA):

1. NFPA 70 "National Electrical Code" (Copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC

F. Underwriters Laboratories, Inc. (UL):

1. UL 294 "UL Standard for Safety - Access Control System Units" (Copyrighted by UL, ANSI approved)
2. UL 486A "UL Standard for Safety - Wire Connectors and Soldering Lugs for Use with Copper Conductors"
3. UL 508 "UL Standard for Safety - Industrial Control Equipment" (Copyrighted by UL, ANSI approved)
4. UL 698 "UL Standard for Safety - Industrial Control Equipment for Use in Hazardous (Classified) Locations" (Copyrighted by UL, ANSI approved)

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms shall be engaged in manufacture of motor starters of types and sizes required, and whose products have been in satisfactory use in similar service for not less than five years.

B. Contractor's Qualifications: Firms shall have at least five years of successful installation experience with projects utilizing motor starters similar to that required for this Project.

C. Compliance: Comply with applicable requirements of IEEE, NEMA and UL standards referenced in Article 1.3 - REFERENCES, and NEC.

D. Testing Agency Qualifications: Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

E. 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.

F. Comply with NFPA 70.

1.5 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes. Include the following:

1. Horsepower
2. NEMA size
3. Enclosure type
4. Voltage
5. Phase
6. Overload type and sizes

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:
    a. Each installed unit's type and details
    b. Factory-installed devices
    c. Nameplate legends
    d. Short-circuit current rating of integrated unit
    e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction
    f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers
2. Wiring Diagrams: For power, signal, and control wiring.
3. Qualification Data: For qualified testing agency.
4. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Field Quality-Control Reports
6. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. Include the following:
    a. Routine maintenance requirements for enclosed controllers and installed components.
    b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
    c. Manufacturer's written instructions for setting field-adjustable overload relays.
    d. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.7 SPARE PARTS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to ten percent (10%) of quantity installed for each size and type, but no fewer than three (3) of each size and type.
2. Control Power Fuses: Equal to ten percent (10%) of quantity installed for each size and type, but no fewer than two (2) of each size and type.

3. Indicating Lights: Two (2) of each type and color installed.
4. Auxiliary Contacts: Furnish one (1) spare for each size and type of magnetic controller installed.

B. Key: Furnish four (4) each to Owner.

1.8 WARRANTY

A. The contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted at the time of final acceptance, or for longer periods of time as specified in those sections of the project manual.

B. The contractor shall repair or replace, at no additional cost to Owner, any item that may become defective within the warranty period.

C. Any manufacturer's warranties concerning any item installed shall be to the Benefit of Owner.

D. The contractor agrees not to void or impair or to allow any sub-contractor to void or impair any warranties regarding products or items installed as part of this project.

E. The repair of faulty workmanship shall be considered to be included in the contract.

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Product: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric
2. Rockwell Automation, Inc.; Allen-Bradley brand
3. Siemens Energy & Automation, Inc.

2.2 GENERAL

A. Provide starters as shown on the drawings. Starters shall be the size, voltage and phase and contain overload heaters which are compatible with the motor provided and as specified herein.

B. All motor starters shall be NEMA rated. IEC devices are not acceptable.

C. Unless noted otherwise, starters shall be selected based on motors type as follows:

1. Single Phase Fractional HP Motors: Manual motor starter as specified below. If automatic control is required for the motor then a full voltage magnetic motor starter shall be used.
2. Three Phase Fractional HP Motors: Magnetic full voltage contactor with bimetallic overload relay as specified below.
3. Three Phase Integral HP Motors (1 hp and above): Magnetic full voltage contactor with solid state overload relay as specified below.

2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: NEMA Type 1
2. Outdoor Locations: Type 3R
3. Other Wet or Damp Indoor Locations: [Type 4]
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12

2.4 FRACTIONAL HORSEPOWER MANUAL CONTROLLERS

A. "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped

B. Configuration: Non-reversing

C. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 20 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; **bimetallic type**

D. Surface mounting

E. Red pilot light

F. Additional Nameplates: [e.g. HIGH and LOW for two-speed controllers]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

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

3.2 COORDINATION

A. Coordinate with other work including, but not limited to, motor and electrical wiring work as necessary to interface the installation of motor starters with other work.

3.3 APPLICATION

A. Thermal Overloads: Motor nameplates shall be checked for full load current rating and allowable temperature rise to determine and set correct overload thermal units for each motor.

3.4 INSTALLATION

A. Wall-Mounted Controllers: Starters shall be rigidly mounted and secured. Individual starters and combination starters shall be mounted with their tops at 5½ feet (1,676mm) above finished floor unless otherwise noted on the drawings. Bolt units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Basic Electrical Materials and Methods."

3.5 FIELD QUALITY CONTROL

A. Upon completion of installation of motor starters and after circuitry has been energized with normal power source, test motor starters to demonstrate capability and compliance with requirements. Replace malfunctioning equipment with new units and proceed with retesting.

B. Acceptance Testing Preparation

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
3. Test each motor for proper phase rotation.
4. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification, Sections 7.5.1.1 (switches). Certify compliance with test parameters.
5. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

3.7 FLASH PROTECTION WARNING SIGNS

A. The electrical contractor shall provide all flash protection warning signs as required by the NEC Article 100.16. Warning signs shall conform to the requirements of NFPA 70E.

1. All electrical equipment such as switchboards, panelboards, control panels, meter socket enclosures, and motor control centers, that are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electrical hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.
2. All warning signs MUST be installed before owner's personnel are trained on the use of the equipment.

3.8 MANUFACTURERS FIELD SERVICE

A. Engage a factory-authorized service representative to inspect field-assembled components and equipment installation including pretesting and adjustment of starters.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.

END OF SECTION

SECTION 26 2416
PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Scope: The work specified in this section includes, but shall not be limited to, providing labor, material, equipment, and services necessary for panelboards as shown on the drawings and as herein specified.

B. Section Includes: The work specified in this section includes, but shall not be limited to, providing the following:

1. Power distribution panelboards.
2. Branch circuit panelboards.

1.2 CODES AND STANDARDS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

C. Federal Specifications (FS):

1.	FS W-C-375B	"Circuit Breakers, Molded Case, Branch Circuit and Service."
2.	FS W-F-870	"Fuseholders and Fuseclips (for Plug and Enclosed Cartridge Fuses)."
3.	FS W-P-115C	"Panel, Power Distribution," Type 1, Class 1.
4.	FS W-S-865	"Switch Box (Enclosed), Surface Mounted."

D. National Electrical Manufacturers Association (NEMA):

1.	NEMA 250	"Enclosures for Electrical Equipment (1000 Volts Maximum)" (copyrighted by NEMA, ANSI approved).
2.	NEMA AB 1	"Molded Case Circuit Breakers and Molded Case Switches."
3.	NEMA KS 1	"Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)" (copyrighted by NEMA, ANSI approved).
4.	NEMA PB 1	"Panelboards" (copyrighted by NEMA, ANSI approved).
5.	NEMA PB 1.1	"General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

E. National Fire Protection Association (NFPA):

1.	NFPA 70	"National Electrical Code" (copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC.

F. Underwriters Laboratories, Inc. (UL):

1.	UL 50	"UL Standard for Safety – Cabinets and Boxes" (copyrighted by UL, ANSI approved).
2.	UL 67	"UL Standard for Safety – Panelboards" (copyrighted by UL, ANSI approved).

3. UL 486A "UL Standard for Safety - Wire Connectors and Soldering Lugs for Use with Copper Conductors."
4. UL 869 "UL Standard for Safety - Service Equipment" (copyrighted by UL, ANSI approved).

QUALITY ASSURANCE

G. Manufacturer's Qualifications: Firms shall be engaged which are in manufacture of panelboards of types and sizes required, and whose products have been in satisfactory use in similar service for not less than five years.

H. Contractor's Qualifications: Firms shall have at least five years of successful installation experience with projects utilizing panelboards similar to that required for this Project.

I. Compliance: Comply with applicable requirements of FS, NEMA and UL standards referenced in Article 1.2 - References, and with NEC.

J. Testing Agency Qualifications: Testing Agency shall be a member of the International Electrical Testing Association and shall be acceptable to authorities having jurisdiction.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 1 - General Requirements.

B. Product Data: Submit manufacturer's product data showing material proposed. Product data shall include manufacturer's technical data and cut sheets on features, performance, electrical characteristics, ratings and finishes.

C. Shop Drawings: Submit complete shop drawings as required to determine acceptability. Shop drawings shall include, but shall not be limited to, the following:

1. Voltage, ampere, AIC, and integrated interrupting ratings.
2. Dimensioned drawings.
3. Finish and mounting type.
4. Main, neutral, equipment ground, and isolated ground bus drawings.
5. Enclosure types and details.
6. Lugs.
7. UL and NEMA labeling for applications required.
8. Nameplate details.
9. Lock hardware.
10. Number and size of spare switches or breakers.
11. Cut sheets on breakers with model numbers highlighted.
12. Technical data and cut sheets on TVSS devices.

D. Operating and Maintenance Manuals: Prepare and deliver complete operating and maintenance manuals. Provide information pertinent to the equipment for preventive maintenance and for replacement of expendable components. Include the items listed below and other features as may be recommended by the equipment manufacturer:

1. Catalog information of the unit installed.
2. Capacity and installation details.
3. Wiring diagrams of electrical components.
4. Complete list of parts with reordering numbers.
5. Time-current curves.

6. Recommended spare parts list.

E. Panel Board Schedules: For installation in panelboard. Submit final versions after load balancing in field.

F. Submit signed receipt showing keys have been turned over to Owner.

G. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle panelboards to avoid damage to materials, components, and finish.

1.5 SPARE PARTS

A. Circuit Breakers: Furnish 10% spare circuit breakers of each type and rating installed. If drawings indicate more spares, provide the quantity as shown on the drawings.

1.6 WARRANTY

A. Panelboards shall be warranted for a minimum period of one year after Project completion or longer if the manufacturer's warranty allows.

1.7 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1. Square D. Co.
2. Erickson Electrical Equipment Co.
3. Local panelboard manufacturer (subject to prequalification).

B. Manufacturer Model: See specifications below for specific manufacturer models to be used.

2.2 GENERAL

A. Provide panelboards, enclosures, and ancillary components of types, sizes, and ratings as indicated in the panelboard schedules and where shown on the drawings.

B. Service: Panelboards shall be rated for the voltage and phase shown on the drawings.

C. Cabinets:

1. Construction: Panelboards shall comply with NEMA 1 requirements unless noted otherwise on drawings. Panelboards shall be enclosed in steel cabinets with the rigidity and gauge of steel complying with UL 50. Wiring gutter space

shall comply with UL 67 and NEC and not be less than 5½" top, bottom and sides. Minimum width shall be 20".

2. Doors: Each panelboard front shall have a door and a flush cylinder tumbler-type lock. Fronts shall have concealed trim clamps. Fronts shall be code gage steel.
3. Finish: Cabinets shall be full-finished steel with rust inhibiting primer and gray electrodeposited baked enamel.
4. Panelboard Directory: Each circuit shall be identified with a typewritten panelboard directory with a transparent cover inside the door.
5. Panelboard Identification: Each panelboard shall have a laminated bakelite nameplate attached to the outside of the panelboard. The nameplate shall include panelboard designation, location, voltage, and phase.
6. Keys: Panelboard locks shall be keyed alike.

D. Interior: Interiors shall be factory-assembled. Interiors shall be designed such that switching and overcurrent protective devices can be removed without disturbing adjacent units or bus bars. Branch breakers shall be arranged using double row construction. Provision for future circuit breakers shall be located at the bottom of the panelboard.

E. Trim: Surface trims shall be the same height and width as box. Flush trims shall overlap the box by ¾" on all sides.

F. Bus:

1. General: Panelboard bus structure and main circuit breaker shall have the current ratings as shown on the drawings. Such rating shall be established by heat rise test with a maximum hot spot temperature on any conductor or bus bar not to exceed 65 degrees C rise above ambient. Test shall comply with UL 67.
2. Bus Capacity: Copper bus bars shall be of sufficient size to provide a current density which does not exceed 1,000 amperes per square inch of bus cross-section, and which does not exceed 200 amperes per square inch at bolted circuit breaker connections.
3. Main Bus: Panelboards shall be provided with a tin plated copper main bus. Bus shall be full length to accommodate the maximum number of overcurrent protective devices for which the panelboard is designed.
4. Neutral Bus: A full-sized (100% rated) neutral bar shall be included for panels shown with a neutral. Where required on drawings, panelboards shall be provided with a 100% or 200% rated tin-plated copper main neutral bus. The neutral bus (100 or 200%) shall be insulated from the cabinet and other parts shall be provided with solderless cable connectors for each circuit breaker.
5. Equipment Ground Bus: Panelboards shall be provided with a solid copper rectangular cross-section equipment ground bus. Equipment ground bus shall be independent of the neutral bus.
6. Isolated Ground Bus: Where called for on the drawings, panelboards shall be provided with a solid copper rectangular cross-section isolated ground bus. Isolated ground bus shall be independent of the neutral and equipment ground bus, and shall be electrically isolated from the cabinet.

G. Mains: All panelboards shall be provided with main circuit breakers, or main lugs only (MLO) as shown on the electrical drawings. Mains shall be field convertible for top or bottom feed.

H. Lugs: Lugs shall be copper compatible with the type and size conductors serving the panelboard and breaker.

I. Short Circuit Ratings: Panelboard short circuit rating shall be as indicated on schedules or the drawings and specified herein. The short circuit rating of the assembled panelboard shall be determined by utilizing the lowest interrupting rating assigned to any circuit breaker installed in that panelboard. Series-rated panelboards are not acceptable.

J. Circuit Breakers: Circuit breakers shall comply with NEMA AB 1 and FS W-C-375. Circuit breakers shall have over-center toggle, mechanism with quick-make, quick-break action. Circuit breakers shall have a handle position indicator and a common trip for two-pole and three-pole breakers. Circuit breakers shall be bolt-on type (plug in is not acceptable) and equipped with individually insulated, braced, and protected connectors. Circuit breakers shall be flush with each other when assembled in the panelboard. Trip ratings shall be as indicated on panelboard schedules or the drawings. Breakers shall be listed for appropriate applications: SWD for fluorescent lighting, HID for high intensity discharge lighting, and HCAR for heating air conditioning and refrigeration equipment.

K. Spare Circuit Breakers: Where a compartment is shown as spare it shall be provided with a circuit breaker of the size, trip and interrupting capacity, and type shown on the drawings.

L. Space: Where space is shown on the drawings, it shall be provided with a bus, shall have a cover, and shall be ready to receive a breaker of the size and type indicated.

M. Where indicated on the drawings, the panelboard shall be listed for service entrance use.

N. Feed-through Lugs: Where required on drawings provide feed-through compression lugs suitable for use with copper conductors. Locate at opposite end of main breaker.

2.3 BRANCH CIRCUIT PANELBOARDS

A. Product: Subject to compliance with requirements, provide one of the following products:

1. "Type NQOD," Square D Co.

B. Short Circuit Ratings: Panelboard short circuit rating shall be as indicated on schedules or the drawings, but not less than 22,000 amps fully rated. The short circuit rating of the assembled panelboard shall be determined by utilizing the lowest interrupting rating assigned to any circuit breaker installed in that panelboard. Series-rated panelboards are not acceptable.

C. Circuit Breakers: Trip ratings shall be as indicated on panelboard schedules or the drawings. The interrupting rating for circuit breakers shall be equal to the full rating of the panelboard as indicated on the drawings and not less than 22,000 rms amperes symmetrical. Breakers shall have inverse time tripping characteristics calibrated for operation in 104F ambient. Breakers shall be UL listed for SWD, HID, and HACR type as required by code.

2.4 SURGE SUPPRESSION DEVICES

A. Where indicated on drawings, panelboards shall incorporate a TVSS device within the panel enclosure.

B. TVSS device shall be category C, B, or A as shown on the drawings and specified herein.

C. TVSS shall use MOV technology, provide protection for all modes of the panel, and be directly coupled to the bus.

D. TVSS shall be listed under UL 1449 and UL 1283.

E. TVSS shall incorporate status lights on each phase.

F. Each suppression element shall be individually fused at 200 kAIC.

G. TVSS EMI/RFI suppression: Minimum 50 dB @ 100 kHz

H. UL 1449 suppression ratings (L-N, L-G, N-G)

1. 208/120V Panels: 400V
2. 480/277V Panels: 800V

I. Category "C" TVSS Minimum Surge Current Ratings:

1. Per Phase : 300,000 amps
2. L-L, L-N, L-G: 150,000 amps

J. Category "B" TVSS Minimum Surge Current Ratings:

1. Per Phase: 200,000 amps
2. L-L, L-N, L-G: 100,000 amps

K. Category "A" TVSS Minimum Surge Current Ratings:

1. Per Phase: 120,000 amps
2. L-L, L-N, L-G: 60,000 amps

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which the work is to be installed, and notify Owner in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate installation of panelboards and enclosures with cable and raceway installation work.

3.3 APPLICATION

A. When a circuit is removed or added to an existing panel, the Contractor shall verify that the remaining load is equally balanced on the existing bus. The Contractor shall ensure that the existing and new circuits are not loaded over 80% percent of capacity. If above conditions exist, then the Contractor shall immediately notify Owner and take corrective action to rectify the condition.

3.4 INSTALLATION

A. General: Install panelboards as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices. Comply with applicable

requirements of NEC, UL, and NEMA standards to ensure that products fulfill requirements. Comply with all applicable requirements of electrical installations in seismic zones.

B. Mounting: Panelboards shall be installed with the panelboard top 6 feet (72 inches) above finished floor or as otherwise indicated on the schedules or drawings. Panelboards shall be installed plumb and level. Mount and anchor in accordance with local seismic zone.

C. Surface Mount: Panelboards shall be rigidly secured by bolting to walls and structures. Provide marine grade plywood installed on wall with panel installed on wood backboard.

D. Spare Raceways in Flush Mounted Panels: Provide one empty ¾" conduit for every three spare branch breakers or bussed spaces available in each recessed panelboard. Stub the conduit to an accessible location 6" above the ceiling.

E. Wiring: Panelboard wiring shall have rounded corners and shall be tied off in bundles with cable ties.

F. Grounding: Provide equipment grounding connections for panelboards. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing Agency: Contractor will engage a qualified independent testing agency to perform specified testing.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches, and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20% between phase loads within a panelboard is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 ADJUSTING

A. Panelboard, locks, and trims shall be adjusted and operated properly.

B. Lugs, bolts, clamps, and screws shall be tightened to manufacturer's recommendation and shall comply with UL 486A.

C. Circuit Breaker adjustable trip settings. Send schedule or table of breakers requiring trip settings to engineer for review at least two weeks before acceptance testing. Include in the schedule or table each breaker and the type and setting adjustments available. Include all time current curves for each type of breaker from manufacturer. Set field adjustable trips on circuit breakers per engineer's direction.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air. Repair exposed surfaces to match original surface.

3.8 DEMONSTRATION

A. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

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