City of Milwaukee

Department of Public Works

Infrastructure Services Division
Facilities Development & Management Section

Northwest Garage – Compressed Natural Gas Fueling Program
3025 West Ruby Avenue
City of Milwaukee, Milwaukee County, Wisconsin

ID 1693-35-72
15% DBE Participation
Project is CMAQ Federally Funded

Bid Set – Final RTA Package
September 2, 2014

Project Number BU110030322
Official Notice No. 22-1-2015

CITY OF MILWAUKEE, WISCONSIN

DEPARTMENT OF PUBLIC WORKS

INFRASTRUCTURE SERVICES DIVISION

FACILITIES DEVELOPMENT &
MANAGEMENT SECTION

PROJECT MANUAL

GOVERNING THE

COMPRESSED NATURAL GAS FUELING STATION

NORTHWEST GARAGE

3025 WEST RUBY AVEUNE

MILWAUKEE, WISCONSIN

Project No. BU110030322

September 2, 2014

Official Notice No. 22-1-2015

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END OF TOC

CITY OF MILWAUKEE
GENERAL OFFICIAL NOTICE
TO CONTRACTORS

Separate sealed bids for each project will be received until 10:30 A.M. , Thursday, February 19, 2015 at which time bids will be publicly opened and read for furnishing all material and doing all work for each project in accordance with the requirements of the respective Official Notice on the bid form furnished in accordance with plans, specifications, contract documents, and proposed form of contract on file in the office of the Department of Public Works, Municipal Building, 841 N. Broadway, Room 506, Milwaukee, Wisconsin, 53202.

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

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

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

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

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

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

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

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

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

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

Signed: GHASSAN KORBAN,
Commissioner of Public Works

Countersigned: W. MARTIN MORICS,
City Comptroller

CITY OF MILWAUKEE
SPECIFIC OFFICIAL NOTICE NO. 22-2015

Sealed bids will be opened on **Thursday, February 19, 2015 at 10:30 A.M**. for the **Northwest Garage-Compressed Natural Gas Fueling Program located at 3025 West Ruby 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/22-2015. 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.

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

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: 160 Working Days. Liquidated

Damages, per diem: **$250.00**

The DBE requirement for this project is **15%** of the contract base bid.
The residency requirement for this project is **40%** of all hours worked on the project.
The Project is CMAQ federally funded.

The apprenticeship requirements for this project are: Apprentices from

2 of the following trade(s) are to be employed: **Carpenter, Mason**

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

DISADVANTAGE BUSINESS ENTERPRISE (DBE): It is the policy for this project that minority business enterprises, as defined by 49 CFR Part 23, shall have the maximum opportunity to participate in performance of this contract. This project has a non-discretionary goal of 15% for Disadvantaged Business Enterprise (DBE).

AFFADAVIT OF NON COLLUSION: The Bidder has examined and carefully prepare the bid from plans and specifications provided , and all addenda, and has checked the same in detail before submitting this bid, and the Bidder, agents, officers or employees have not either directly or indirectly entered into any agreements, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with this bid.

AFFIRMATIVE ACTION: The Bidder agrees to ensure equal opportunity in employment to all applicants and employees and to take affirmative action to attain a representative workforce.

WAGE SCALE: Both State and Federal Prevailing W age Rates are part of this contract and included in the Project Manual. The highest prevailing wage rate of either the state or federal wage rates shall be used for all times.

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.

Plans and project manual for this project may be viewed in Buildings & Fleet Services, Room 602, Municipal
Building, 841 North Broadway, Milwaukee, Wisconsin

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.

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.

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

Pre-Bid Meeting: A Pre-Bid Meeting is scheduled for **Wednesday, February 4, 2015 at 2 p.m.** in Room 606 of the Frank
Zeidler Building, 841 North Broadway, Milwaukee, Wisconsin**.** Bidder participation is urged to become familiar with all aspects of the project and bidding requirements.

Signed:

_____

GHASSAN KORBAN
Commissioner of Public Works

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.

UNIT PRICES

Each bidder shall provide on the bid proposal the following unit prices that were used in arriving at the Base Bid. The unit prices will be used for additions to or deductions from work required under the contract.

Unit Price No. 1

State the Unit Price per square foot for the saw cutting, removal and replacement of concrete slab per detail 12/S201. for replacement of existing underground piping.

Unit Price No. 2

State the unit price per lineal foot to provide 6 inch diameter solid wall PVC pipe, PVC socket fittings, and solvent–cemented joints for the replacement of existing underground sanitary sewer. Include trenching and backfill as indicated in the specifications and drawings.

Unit Price No. 3

State the unit price per lineal foot to provide 8 inch diameter solid wall PVC pipe, PVC socket fittings, and solvent–cemented joints for the replacement of existing underground sanitary sewer. Include trenching and backfill as indicated in the specifications and drawings.

Unit Price No. 4

State the unit price per lineal foot to provide 10 inch diameter solid wall PVC pipe, PVC socket fittings, and solvent–cemented joints for the replacement of existing underground storm sewer. Include trenching and backfill as indicated in the specifications and drawings.

CONTRACT AWARD

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

CONTRACT BREAKDOWN

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

SITE VISIT

All contractors shall visit the site, consult the drawings and project manual, be familiar with the work of other contractors and determine for himself all conditions affecting the work.

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

CONSTRUCTION START AND COMPLETION DATES

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

BASE BID EXCLUSIONS

None.

ADDITIONAL PLANS/PROJECT MANUALS

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

SECTION 00700: GENERAL CONDITIONS

1. SCOPE:

A. Index:

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

2. Department of Public Works General Specifications:

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

3. Definitions:

A. Owner: City of Milwaukee.

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

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

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

E. Contract Drawings: Drawings of the work to be done as listed hereafter in Section 00850 Drawing Schedule and/or Section 00870 Plans and Details.

4. Control of Work and Materials:

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

Facilities Manager shall be made and revised prints submitted as above. The Facilities Manager's approval of drawings shall not relieve the contractor of responsibility for errors.

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

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

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

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

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

5. Samples and Tests:

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

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

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

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

when such tests are permitted by A.S.T.M. Specifications and approved by the Commissioner or subsequent tests ordered by the Commissioner will be made at the expense of the contractor.

6. Project Coordination:

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

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

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

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

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

7. Supervision of Work:

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

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

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

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

8. Technical Specifications and Drawings:

A. Governing order of Contract Documents:

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

Anything mentioned in the Technical Specifications and not shown on the drawings or shown on the drawings and not mentioned in the Technical Specifications, shall

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

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

9. Safety Regulations:

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

10. Code Rules:

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

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

Railroad Insurance and Coordination.

A Description

Comply with subsection 107.17 of the standard specifications for all work affecting Wisconsin & Southern Railroad LLC.

A.1 Railroad Insurance Requirements

In addition to standard spec 107.26, provide railroad protective liability insurance coverage as specified in standard spec 107.17.3. Insurance is filed in the name of Wisconsin & Southern Railroad LLC and Wisconsin Central Ltd. d/b/a Canadian National.

Notify evidence of the required coverage, and duration to Ben Meighan, Superintendent of Maintenance of Way, Wisconsin and Southern Railroad LLC, 1890 East Johnson Street, Madison, WI 53704, telephone 608-243-9129, ext 201, FAX 608-243-9225, email bmeighan@wsorrailroad.com. Include the following information on the insurance document:

Project Id: 1693-35-72
Route Name: Compressor Natural Gas Fueling Station, Milwaukee County
Crossing ID: No Crossing#
Railroad Subdivision: North Milwaukee Subdivision
Railroad Milepost: Milepost 92.9

A.2 Work by Railroad

The railroad will perform the work described in this section, except for work described in other special provisions and will be accomplished without cost to the contractor. None

A.3 Names and addresses of Railroad Representatives for Consultation and Coordination

Contact Ben Meighan, Superintendent of Maintenance of Way, Wisconsin and Southern Railroad LLC., 1890 East Johnson Street, Madison, WI 53704, telephone 608-243-9129, ext 201, FAX 608-243-9225, email bmeighan@wsorrailroad.com, for consultation on railroad requirements during construction.

Amend standard spec 108.4 to include the railroad in the distribution of the initial bar chart, and monthly schedule updates. The bar chart shall specifically show work involving coordination with the railroad.

A.4 Temporary Grade Crossing

If a temporary grade crossing is desired, submit a written request to the railroad representative named in A.3 several weeks prior to the time needed. Approval is subject to the discretion of the railroad. The department has made no arrangements for a temporary grade crossing.

A.5 Train Operation

Approximately 10 WSOR and 14 WCL through freight trains operate daily through the construction site. Through freight trains operate at up to 10 mph. In addition to through movements, there are switching movements at slower speeds.

END OF SECTION

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 SCALE
See attached Wage Rate Determination.

PREVAILING WAGE RATE DETERMINATION
Issued by the State of Wisconsin
Department of Workforce Development
Pursuant to s. 66.0903, Wis. Stats.
Issued On: 01/07/2015
Amended On: 01/26/2015

DETERMINATION NUMBER:	201500024
EXPIRATION DATE:	Prime Contracts MUST Be Awarded or Negotiated On Or Before 12/31/2015. 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 $1.50/hr on 6/1/2015; 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.	34.13	20.61	54.74
102	Boilermaker Future Increase(s): Add $1.50/hr. on 01/01/2016	33.35	28.24	61.59
103	Bricklayer, Blocklayer or Stonemason Future Increase(s): Add $1.35on 06/01/2015; 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.	35.89	18.64	54.53
104	Cabinet Installer Future Increase(s): Add $1.42/hr on 6/1/2015; Add $1.42/hr on 6/1/2016.	32.72	16.00	48.72
105	Carpenter Future Increase(s): Add $1.50/hr on 6/1/2015; 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.	34.13	20.61	54.74
106	Carpet Layer or Soft Floor Coverer	33.68	19.98	53.66
107	Cement Finisher Future Increase(s): Add $1.30 on 06/01/2015; Add $1.40 on 06/06/2016	32.09	19.21	51.30
108	Drywall Taper or Finisher Future Increase(s): Add $.90/hr eff. 06/01/2015; Add $1.00/hr eff. 06/01/2016; Add $1.05/hr eff. 06/01/2017	29.97	20.74	50.71

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
109	Electrician 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.	33.93	22.77	56.70
110	Elevator Constructor	43.84	27.09	70.93
111	Fence Erector	23.73	19.09	42.82
112	Fire Sprinkler Fitter	39.10	19.94	59.04
113	Glazier Future Increase(s): Add $.75/hr eff. 06/01/2015; Add $.90/hr eff. 06/01/2016	34.19	18.50	52.69
114	Heat or Frost Insulator	33.43	25.81	59.24
115	Insulator (Batt or Blown) Future Increase(s): Add $1.42/hr on 6/1/2015; Add $1.42/hr on 6/1/2016.	32.72	16.00	48.72
116	Ironworker 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.	30.77	23.97	54.74
117	Lather	33.68	19.81	53.49
118	Line Constructor (Electrical)	37.43	18.19	55.62
119	Marble Finisher	20.00	0.52	20.52
120	Marble Mason	35.37	17.99	53.36
121	Metal Building Erector	22.05	8.08	30.13
122	Millwright	28.53	25.19	53.72
123	Overhead Door Installer	20.00	6.10	26.10
124	Painter Future Increase(s): Add $.90/hr on 06/01/2015; 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.	29.62	20.74	50.36
125	Pavement Marking Operator	30.10	18.08	48.18

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
126	Piledriver Future Increase(s): Add $1.50/hr on 6/1/2015; 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.	30.11	26.51	56.62
127	Pipeline Fuser or Welder (Gas or Utility)	31.88	20.89	52.77
129	Plasterer Premium Increase(s): Add $.40/hr for swing stage work.	31.21	19.93	51.14
130	Plumber	38.37	19.55	57.92
132	Refrigeration Mechanic Future Increase(s): Add $1.70 on 6/1/15	41.01	21.54	62.55
133	Roofer or Waterproofer Future Increase(s): Add $1.25/hr eff. 06/01/2015; Add $1.25/hr eff. 06/01/2016	29.65	18.15	47.80
134	Sheet Metal Worker	36.94	20.22	57.16
135	Steamfitter	41.01	21.54	62.55
137	Teledata Technician or Installer Future Increase(s): Add $.86/hr on 6/1/2015. 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.	25.63	17.25	42.88
138	Temperature Control Installer	39.76	21.09	60.85
139	Terrazzo Finisher	20.00	0.52	20.52
140	Terrazzo Mechanic	31.18	17.35	48.53
141	Tile Finisher	24.24	17.54	41.78
142	Tile Setter	30.38	17.33	47.71
143	Tuckpointer, Caulker or Cleaner Future Increase(s): Add $1.35on 06/01/2015; Add $1.45 on 06/01/2016 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.	34.28	18.48	52.76
144	Underwater Diver (Except on Great Lakes)	35.40	15.90	51.30

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
146	Well Driller or Pump Installer	25.32	15.65	40.97
147	Siding Installer	36.17	19.44	55.61
150	Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	30.16	15.11	45.27
151	Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	31.60	15.71	47.31
152	Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	27.65	14.49	42.14
153	Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	27.83	15.01	42.84
154	Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	24.00	11.57	35.57

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	34.07	18.10	52.17
203	Three or More Axle	23.49	12.02	35.51
204	Articulated, Euclid, Dumptor, Off Road Material Hauler Future Increase(s): Add $1.60/hr on 5/30/2016.	33.02	18.70	51.72
205	Pavement Marking Vehicle	20.85	11.02	31.87
207	Truck Mechanic	23.49	12.02	35.51

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 $1.35/hr eff. 06/01/2015; Add $1.25/hr eff. 06/06/2016 Premium Increase(s): Add $.11 for mortar mixer, fork lift operator, air and electric equipment and power buggy operators; Add $.22 for jackhammer operator, certified welder, gunite machineman.	29.01	17.22	46.23
302	Asbestos Abatement Worker	22.05	19.16	41.21
303	Landscaper	15.44	11.20	26.64
310	Gas or Utility Pipeline Laborer (Other Than Sewer and Water)	20.13	17.79	37.92

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased) Premium Increase(s): DOT PREMIUMS: Pay two times the hourly basic rate on New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Christmas Day.	18.06	16.76	34.82
314	Railroad Track Laborer	14.50	4.39	18.89
315	Final Construction Clean-Up Worker	28.31	12.30	40.61

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 $1.50/hr on 6/1/2015; Add $1.60/hr on 5/30/2016.	34.47	18.70	53.17
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 $1.50/hr on 6/1/2015; Add $1.60/hr on 5/30/2016.	34.17	18.70	52.87
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 $1.50/hr on 6/1/2015; Add $1.60/hr on 5/30/2016.	34.17	18.70	52.87

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Premium Increase(s): Add $.50/hr for Friction Crane, Lattice Boom or Crane Certification (CCO).	41.65	21.71	63.36
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.	35.72	17.85	53.57
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.	35.46	20.40	55.86

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. Future Increase(s): Add $1.55/hr on 6/1/2015. 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.	40.61	20.15	60.76
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). Future Increase(s): Add $1.55/hr on 6/1/2015. Premium Increase(s):	40.11	20.15	60.26

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
	Crane Operators with CCO certification add $.50/hr.			
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). Future Increase(s): Add $1.55/hr on 6/1/2015. Premium Increase(s): Crane Operators with CCO certification add $.50/hr.	39.61	20.15	59.76
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). Future Increase(s): Add $1.55/hr on 6/1/2015.	38.92	20.15	59.07
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. Future Increase(s): Add $1.55/hr on 6/1/2015.	37.04	20.15	57.19

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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. Future Increase(s): Add $1.55/hr on 6/1/2015.	31.89	20.15	52.04
514	Gas or Utility Pipeline, Except Sewer & Water (Primary Equipment). Future Increase(s): Add $1/hr on 6/1/2015; Add $1/hr on 5/30/2016.	36.34	22.14	58.48
515	Gas or Utility Pipeline, Except Sewer & Water (Secondary Equipment). Future Increase(s): Add $1.65/hr on 6/1/2015.	34.06	19.35	53.41
516	Fiber Optic Cable Equipment	28.89	17.95	46.84

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	35.37	17.99	53.36
105	Carpenter Future Increase(s): Add $1.50/hr on 6/1/2015; 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.	34.13	20.61	54.74
107	Cement Finisher Future Increase(s): Add $1.87 on 6/1/15; 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.	35.18	16.78	51.96
109	Electrician	47.76	0.00	47.76
111	Fence Erector	23.73	19.09	42.82
116	Ironworker	31.50	20.01	51.51
118	Line Constructor (Electrical)	37.43	18.19	55.62
125	Pavement Marking Operator	30.10	18.08	48.18
126	Piledriver	29.56	25.71	55.27
130	Plumber	21.50	0.00	21.50
135	Steamfitter	39.76	21.09	60.85
137	Teledata Technician or Installer	24.89	17.15	42.04
143	Tuckpointer, Caulker or Cleaner	33.76	17.82	51.58
144	Underwater Diver (Except on Great Lakes)	35.40	15.90	51.30
146	Well Driller or Pump Installer	25.32	15.65	40.97
150	Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	35.55	15.57	51.12

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	31.60	15.19	46.79
152	Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	27.65	13.44	41.09
153	Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	25.68	13.28	38.96
154	Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	21.75	12.97	34.72

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 Future Increase(s): Add $1.15/hr on 6/1/2015. 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.	25.18	18.31	43.49
203	Three or More Axle	18.00	0.00	18.00
204	Articulated, Euclid, Dumptor, Off Road Material Hauler	32.89	18.96	51.85
205	Pavement Marking Vehicle	20.85	11.02	31.87
207	Truck Mechanic	18.00	0.00	18.00

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 $1.35/hr eff. 06/01/2015; 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.	29.16	17.72	46.88
303	Landscaper	39.43	0.00	39.43
304	Flagperson or Traffic Control Person	31.95	0.00	31.95
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	17.71	16.01	33.72

314	Railroad Track Laborer	14.50	4.39	18.89

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. Future Increase(s): Add $1.55/hr on 6/1/2015. Premium Increase(s): Add $.25/hr for operating tower crane.	37.24	20.10	57.34
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). Future Increase(s): Add $1.55/hr on 6/1/2015. Premium Increase(s): Add $.25/hr for operating tower crane.	36.46	20.10	56.56
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). Future Increase(s): Add $1.55/hr on 6/1/2015. Premium Increase(s): Add $.25/hr for operating tower crane.	35.51	20.10	55.61

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.	36.79	19.15	55.94
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.	50.50	0.42	50.92
526	Boiler (Temporary Heat); Forklift; Greaser; Oiler.	31.64	19.15	50.79
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.	35.72	17.85	53.57
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.	35.46	20.40	55.86

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	35.37	17.99	53.36
105	Carpenter	33.68	19.99	53.67
107	Cement Finisher Future Increase(s): Add $1.87 on 6/1/15; 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.	32.75	19.21	51.96
109	Electrician 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.	33.93	22.77	56.70
111	Fence Erector	23.73	19.09	42.82
116	Ironworker 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.	30.77	23.97	54.74
118	Line Constructor (Electrical)	37.43	18.19	55.62
124	Painter	29.22	16.69	45.91
125	Pavement Marking Operator	30.27	18.79	49.06
126	Piledriver Future Increase(s): Add $1.50/hr on 6/1/2015; 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.	30.11	26.51	56.62
133	Roofer or Waterproofer	29.40	17.05	46.45

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
137	Teledata Technician or Installer	24.89	17.15	42.04
143	Tuckpointer, Caulker or Cleaner	33.76	17.82	51.58
144	Underwater Diver (Except on Great Lakes)	35.40	15.90	51.30
150	Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	35.55	15.57	51.12
151	Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	31.60	14.64	46.24
152	Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	27.65	13.44	41.09
153	Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	25.68	12.83	38.51
154	Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	21.75	11.63	33.38

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 Future Increase(s): Add $1.15/hr on 6/1/2015. 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.	25.18	18.31	43.49
203	Three or More Axle Future Increase(s): Add $1.15/hr on 6/1/2015. 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.	25.28	18.31	43.59
204	Articulated, Euclid, Dumptor, Off Road Material Hauler Future Increase(s): Add $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	30.27	21.15	51.42
205	Pavement Marking Vehicle	23.16	17.13	40.29
206	Shadow or Pilot Vehicle	24.37	17.77	42.14

207	Truck Mechanic	24.52	17.77	42.29

LABORERS

Fringe Benefits Must Be Paid On All Hours Worked

CODE	TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
301	General Laborer Future Increase(s): Add $1.05/hr eff. 06/01/2015; 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).	27.06	20.03	47.09
302	Asbestos Abatement Worker	22.05	18.41	40.46
303	Landscaper Future Increase(s): Add $1.05/hr eff. 06/01/2015; 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).	27.06	20.03	47.09
304	Flagperson or Traffic Control Person	22.55	19.37	41.92
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	17.71	16.01	33.72
314	Railroad Track Laborer	14.50	4.39	18.89

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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	37.72	21.15	58.87
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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	37.22	21.15	58.37

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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	36.72	21.15	57.87

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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	36.46	21.15	57.61
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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	36.17	21.15	57.32
536	Fiber Optic Cable Equipment.	28.89	17.95	46.84
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.	35.72	17.85	53.57
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.	35.46	20.40	55.86

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	35.37	17.99	53.36
105	Carpenter Future Increase(s): Add $1.42/hr on 6/1/2015; 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.	32.72	16.00	48.72
107	Cement Finisher	30.96	18.53	49.49
109	Electrician 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.	33.93	22.77	56.70
111	Fence Erector	23.73	19.09	42.82
116	Ironworker	30.52	23.47	53.99
118	Line Constructor (Electrical)	37.43	18.19	55.62
124	Painter	29.52	19.99	49.51
125	Pavement Marking Operator	30.10	18.08	48.18
126	Piledriver	29.56	25.71	55.27
133	Roofer or Waterproofer	29.40	17.05	46.45
137	Teledata Technician or Installer	24.89	17.15	42.04
143	Tuckpointer, Caulker or Cleaner	33.76	17.82	51.58
144	Underwater Diver (Except on Great Lakes)	35.40	15.90	51.30
150	Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	35.55	15.57	51.12
151	Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	31.60	15.19	46.79
152	Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	27.65	13.44	41.09
153	Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	25.68	13.28	38.96
154	Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	21.75	12.97	34.72

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 Future Increase(s): Add $1.15/hr on 6/1/2015. 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.	25.18	18.31	43.49
203	Three or More Axle	18.00	0.00	18.00
204	Articulated, Euclid, Dumptor, Off Road Material Hauler Future Increase(s): Add $1.60/hr on 6/2/2015; Add $1.60/hr on 6/3/2016.	33.69	19.78	53.47
205	Pavement Marking Vehicle	20.85	11.02	31.87
206	Shadow or Pilot Vehicle	24.37	17.77	42.14
207	Truck Mechanic	18.00	0.00	18.00

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	24.75	19.69	44.44
303	Landscaper Future Increase(s): Add $1.05/hr eff. 06/01/2015; 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).	27.06	20.03	47.09
304	Flagperson or Traffic Control Person	25.67	12.66	38.33
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	17.71	16.01	33.72
314	Railroad Track Laborer	14.50	4.39	18.89

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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	37.72	21.15	58.87
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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	37.22	21.15	58.37

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.	35.72	17.85	53.57
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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	36.46	21.15	57.61
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.	35.17	20.40	55.57
546	Fiber Optic Cable Equipment.	28.89	17.95	46.84

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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.	41.65	21.71	63.36
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.	35.72	17.85	53.57
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.	35.46	20.40	55.86

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.	36.72	20.40	57.12
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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	37.22	21.15	58.37

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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 $1.25/hr on 6/1/2015; Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017.	36.17	20.80	56.97
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 $1.25/hr on 6/1/2015; Add $1.30/hr on 6/1/2016; Add $1.25/hr on 6/1/2017.	36.17	20.80	56.97

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
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 $1.25/hr on 6/1/2015; 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://www.dot.wi.gov/business/civilrights/laborwages/pwc.htm.	36.17	21.15	57.32
556	Fiber Optic Cable Equipment.	27.89	17.20	45.09

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	33.07	16.07	49.14
102	Boilermaker	32.05	28.04	60.09
103	Bricklayer, Blocklayer or Stonemason	23.89	4.78	28.67
104	Cabinet Installer	18.00	0.00	18.00
105	Carpenter	25.00	6.52	31.52
106	Carpet Layer or Soft Floor Coverer	30.00	0.00	30.00
107	Cement Finisher	26.60	3.99	30.59
108	Drywall Taper or Finisher	18.00	5.75	23.75
109	Electrician 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.	33.93	22.77	56.70
110	Elevator Constructor	23.26	0.00	23.26
111	Fence Erector	19.00	1.34	20.34
112	Fire Sprinkler Fitter	39.00	18.00	57.00
113	Glazier Future Increase(s): Add $.75/hr eff. 06/01/2015; Add $.90/hr eff. 06/01/2016	37.07	14.42	51.49
114	Heat or Frost Insulator	33.43	25.81	59.24
115	Insulator (Batt or Blown)	20.00	0.00	20.00
116	Ironworker	31.50	11.33	42.83
117	Lather	25.00	6.52	31.52
119	Marble Finisher	20.00	0.52	20.52
120	Marble Mason	23.89	4.78	28.67
121	Metal Building Erector	18.00	5.88	23.88

CODE	Fringe Benefits Must Be Paid On All Hours Worked TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY $	HOURLY FRINGE BENEFITS $	TOTAL $
123	Overhead Door Installer	28.00	1.61	29.61
124	Painter	18.00	4.50	22.50
125	Pavement Marking Operator	18.75	2.47	21.22
129	Plasterer	22.00	0.00	22.00
130	Plumber	36.47	20.47	56.94
132	Refrigeration Mechanic	17.00	13.52	30.52
133	Roofer or Waterproofer Future Increase(s): Add $1.25/hr eff. 06/01/2015; Add $1.25/hr eff. 06/01/2016	29.65	18.15	47.80
134	Sheet Metal Worker	26.13	20.22	46.35
135	Steamfitter	23.62	16.12	39.74
137	Teledata Technician or Installer	18.00	28.48	46.48
138	Temperature Control Installer	22.00	2.45	24.45
139	Terrazzo Finisher	20.00	0.52	20.52
140	Terrazzo Mechanic	30.71	16.52	47.23
141	Tile Finisher	23.77	16.52	40.29
142	Tile Setter	30.50	0.68	31.18
143	Tuckpointer, Caulker or Cleaner	14.00	8.75	22.75
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	17.25	5.70	22.95
203	Three or More Axle	23.49	14.07	37.56
205	Pavement Marking Vehicle	20.85	11.02	31.87
207	Truck Mechanic	23.49	14.07	37.56

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	15.00	10.33	25.33
302	Asbestos Abatement Worker	16.50	8.21	24.71
303	Landscaper	12.00	0.00	12.00
311	Fiber Optic Laborer (Outside, Other Than Concrete Encased)	17.71	16.01	33.72
315	Final Construction Clean-Up Worker	10.00	2.21	12.21

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.	36.06	19.02	55.08

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.	36.79	18.81	55.60

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

General Decision Number: WI140001 08/15/2014 WI1

Superseded General Decision Number: WI20130001

State: Wisconsin

Construction Type: Building

Counties: Milwaukee, Ozaukee, Washington and Waukesha
Counties in Wisconsin.

BUILDING CONSTRUCTION PROJECTS (Does not include residential
construction consisting of single family homes and apartments
up to and including 4 stories)

Modification Number	Publication Date
0	01/03/2014
1	02/07/2014
2	03/14/2014
3	06/27/2014
4	08/01/2014
5	08/15/2014

ASBE0205-001 06/01/2001

	Rates	Fringes
Asbestos Removal worker/hazardous material handler Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials from mechanical systems, whether they contain asbestos or not	$ 17.90	4.45

BOIL0107-001 01/01/2013

	Rates	Fringes
BOILERMAKER		
Boilermaker	$ 31.09	27.11
Small Boiler Repair (under 25,000 lbs/hr)	$ 26.91	16.00

BRWI0005-001 06/01/2013

	Rates	Fringes
TERRAZZO WORKER	$ 30.71	16.78
TILE LAYER	$ 29.71	16.78

BRWI0008-001 06/01/2013

	Rates	Fringes
BRICKLAYER	$ 35.37	18.47

BRWI0008-003 06/01/2011

	Rates	Fringes
Marble Mason	$ 35.58	16.07

CARP0264-001 06/01/2009

	Rates	Fringes
Carpenter & Soft Floor Layer (Including Acoustical work and Drywall hanging; Excluding Batt Insulation)	$ 31.38	16.03

CARP2337-002 06/01/2009

	Rates	Fringes
MILLWRIGHT	$ 28.30	20.70

CARP2337-008 06/01/2009

	Rates	Fringes
PILEDRIVERMAN	$ 28.11	21.08

ELEC0494-001 06/01/2013

	Rates	Fringes
ELECTRICIAN	$ 32.82	22.51

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* ELEC0494-003 06/01/2014

	Rates	Fringes
Sound & Communications		
Installer	$ 16.47	14.84
Technician	$ 25.63	17.21

Installation, testing, maintenance, operation and servicing of all sound, intercom, telephone interconnect, closed circuit TV systems, radio systems, background music systems, language laboratories, electronic carillion, antenna distribution systems, clock and program systems and low-voltage systems such as visual nurse call, audio/visual nurse call systems, doctors entrance register systems. Includes all wire and cable carrying audio, visual, data, light and radio frequency signals. Includes the installation of conduit, wiremold, or raceways in existing structures that have been occupied for six months or more where required for the protection of the wire or cable, but does not mean a complete conduit or raceway system. work covered does not include the installation of conduit, wiremold or any raceways in any new construction, or the installation of power supply outlets by means of which external electric power is supplied to any of the foregoing equipment or products

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ELEV0015-001 01/01/2014

	Rates	Fringes
ELEVATOR MECHANIC	$ 43.84	26.785

FOOTNOTE:
PAID VACATION: 8% of regular basic for employees with more than 5 years of service, and 6% for 6 months to 5 years of service.
PAID HOLIDAYS: New Years Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Friday after Thanksgiving, and Christmas Day.

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* ENGI0139-001 06/01/2014

KENOSHA, MILWAUKEE, OZAUKEE, RACINE, WASHINGTON, AND WAUKESHA COUNTIES

	Rates	Fringes
Power Equipment Operator		
Group 1	$ 40.61	19.90
Group 2	$ 40.11	19.90
Group 3	$ 39.61	19.90
Group 4	$ 38.92	19.90
Group 5	$ 37.04	19.90
Group 6	$ 31.89	19.90

HAZARDOUS WASTE PREMIUMS:
EPA Level "A" Protection: $3.00 per hour
EPA Level "B" Protection: $2.00 per hour
EPA Level "C" Protection: $1.00 per hour

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: Cranes, Tower Cranes, Pedestal Tower Cranes and Derricks with or w/o attachments with a lifting capacity of over 100 tons; or Cranes, Tower Cranes, Pedestal Tower Cranes and Derricks with boom, leads, and/or jib lengths measuring 176 feet or longer; Self-Erecting Tower Cranes over 4000 lbs lifting capacity; All Cranes with Boom Dollies; Boring Machines (directional); Master Mechanic. $0.50 additional per hour per 100 tons or 100 ft of boom over 200 ft or lifting capacity of crane over 200 tons to a maximum of 300 tons or 300 ft. Thereafter an increase of $0.01 per ft or ton, whichever is greater.

GROUP 2: Cranes, Tower Cranes, Pedestal Tower Cranes and Derricks with or without attachments with a lifting capacity of 100 tons or less; or Cranes, Tower Cranes Portable Tower Cranes, Pedestal Tower Cranes and Derricks with boom, leadsand/or jib lengths measuring 175 feet or less; Backhoes (excavators) 130,000 lbs and over; Caisson Rigs; Pile Drivers; Boring Machines (vertical or horizontal), Versi-Lift, Tri-Lift, Gantry 20,000 lbs & over.

GROUP 3: Backhoe (excavator) under 130,000 lbs;Self-erecting Tower Crane 4000 lbs & under lifting capacity;Traveling Crane (bridge type); Skid Rigs; Dredge Operator; Mechanic; Concrete Paver (over 27E); Concrete Spreader and Distributor; Forklift/ Telehandler (machinery- moving / steel erection); Hydro Blaster, 10,000 psi and over

GROUP 4: Material Hoists; Stack Hoists; Hydraulic Backhoe (tractor or truck mounted); Hydraulic Crane, 5 tons or under (tractor or truck mounted); Hoist (tuggers 5 tons & over); Hydro-Excavators/Daylighters; Concrete Pumps Rotec type Conveyors; Tractor/Bulldozer/End Loader (over 40 hp); Motor Patrol; Scraper Operator; Sideboom; Straddle Carrier; Welder; Bituminous Plant and Paver Operator; Roller over 5 tons; Rail Leveling Machine (Railroad); Tie Placer; Tie Extractor; Tie Tamper; Stone Leveler; Rotary Drill Operator and Blaster; Percussion Drill Operator; Air Track Drill and/or Hammers; Gantrys (under 20,000 lbs); Tencher (wheel type or chain type having 8 inch or larger bucket); Milling Machine; Off-Road Material Haulers.

GROUP 5: Backfiller; Concrete Auto Breaker (large); Concrete Finishing Machines (road type); Rubber Tired Roller; Concrete Batch Hopper; Concrete Conveyor Systems; Grout Pumps; Concrete Mixers (14S or over); Screw Type Pumps and Gypsum Pumps; Tractor, Bulldozer, End Loader (under 40 hp); Trencher (chain type, bucket under 8 inch); Industrial Locomotives; Rollers under 5 tons; Stump Grinder/Chipper (Large); Timber Equipment; Firemen (pile drivers and derricks); Personnel Hoist, Telehandler over 8000 lbs; Robotic Tool Carrier with or without attachments

GROUP 6: Tampers - Compactors (riding type); Assistant Engineer; A-Frames and Winch Trucks; Concrete Auto Breaker; Hydrohammers (small); Brooms and Sweepers; Hoist (tuggers under 5 tons); Boats (Tug, Safety, Work Barges, Launch); Shouldering Machine Operator; Prestress Machines; Screed Operator; Stone Crushers and Screening Plants; Screed Operators (milling machine), Farm or Industrial Tractor Mounted Equipment; Post Hole Digger; Fireman (asphalt plants); Air Compressors over 400 CFM; Generators, over 150 KW; Augers (vertical and horizontal); Air, Electric, Hydraulic Jacks (slipform); Skid Steer Loaders (with or without attachments); Boiler Operators (temporary heat); Refrigeration Plant/Freeze Machines; Power Pack Vibratory/Ultra Sound Drivers and Extractors; Welding Machines; Heaters (mechanical); Pumps; Winches (small electric); Oiler and Greaser; Rotary Drill Tender; Conveyor; Forklifts/Telehandler 8000 lbs & under; Elevators: Automatic Hoists; Pumps (well points); Combination Small Equipment Operators

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IRON0008-005 06/01/2013

	Rates	Fringes
IRONWORKER	$ 30.52	23.47

Paid Holidays: New Year's Day, Memorial Day, July 4th, Labor Day, Thanksgiving Day & Christmas Day.

LABO0113-001 06/01/2013

	Rates	Fringes
LABORER		
(1) General Laborer (Including Plaster Tender)	$ 28.31	16.54
(2) Air & Electric Equipment, Mortar Mixer, Scaffold Builder, Erector, and Swing Stage	$ 28.42	16.54
(3) Jackhammer Operator, Gunnite Machine Man	$ 28.53	16.54
(4) Caisson Worker - Topman	$ 28.62	16.54
(5) Construction Specialist	$ 28.78	16.54
(6) Nozzleman	$ 28.82	16.54
(7) Caisson Work	$ 28.97	16.54
(8) Barco Tamper	$ 29.53	16.54

LABO0113-010 06/01/2013

	Rates	Fringes
Asbestos Laborer		
Asbestos Abatement [Preparation, removal, and encapsulation of hazardous materials from non-mechanical systems]	$ 28.31	16.54

PAIN0781-001 06/01/2013

	Rates	Fringes
Painters:		
(1) Brush, Roller	$ 29.52	20.04
(2) Spray & Sandblast	$ 30.27	20.04
(3) Drywall Taper/Finisher	$ 29.87	20.04

PAIN1204-002 06/01/2012

	Rates	Fringes
GLAZIER	$ 34.19	18.25

PLAS0599-004 06/01/2013

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 31.47	18.53

PLAS0599-005 06/01/2013

	Rates	Fringes
PLASTERER	$ 30.96	19.18

PLUM0075-001 01/01/2013

	Rates	Fringes
PLUMBER (Including HVAC work)	$ 37.97	17.97

PLUM0601-001 01/01/2013

	Rates	Fringes
PIPEFITTER (Including HVAC work)	$ 39.26	19.91

SFWI0183-001 01/01/2013

	Rates	Fringes
SPRINKLER FITTER	$ 38.50	21.03

SHEE0018-001 06/01/2011

	Rates	Fringes
Sheet Metal Worker (Including HVAC duct work and Technicians)	$ 37.20	17.01

TEAM0662-003 05/01/2010

	Rates	Fringes
TRUCK DRIVER		
1 & 2 Axles	$ 25.09	15.20
3 or more Axles	$ 25.24	15.20

SUWI2002-002 01/23/2002

	Rates	Fringes
Asbestos Worker/Heat and Frost Insulator	$ 25.36	8.37
Laborers:		
Concrete Worker	$ 16.34	3.59
Landscape	$ 8.73	8.40
ROOFER	$ 18.01	3.28
Tile & Marble Finisher	$ 13.89	7.43

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is union or non-union.

Union Identifiers

An identifier enclosed in dotted lines beginning with characters other than "SU" denotes that the union classification and rate have found to be prevailing for that classification. Example: PLUM0198-005 07/01/2011. The first four letters , PLUM, indicate the international union and the four-digit number, 0198, that follows indicates the local union number or district council number where applicable , i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2011, following these characters is the effective date of the most current negotiated rate/collective bargaining agreement which would be July 1, 2011 in the above example.

Union prevailing wage rates will be updated to reflect any changes in the collective bargaining agreements governing the rates.

0000/9999: weighted union wage rates will be published annually each January.

Non-Union Identifiers

Classifications listed under an "SU" identifier were derived from survey data by computing average rates and are not union rates; however, the data used in computing these rates may include both union and non-union data. Example: SULA2004-007 5/13/2010. SU indicates the rates are not union majority rates, LA indicates the State of Louisiana; 2004 is the year of the survey; and 007 is an internal number used in producing the wage determination. A 1993 or later date, 5/13/2010, indicates the classifications and rates under that identifier were issued as a General Wage Determination on that date.

Survey wage rates will remain in effect and will not change until a new survey is conducted.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

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.

Sheet No.	Title
	Title Drawings
T1.1	Title Sheet
	Civil Drawings
C101	Site Demolition Plan
C102	Site Plan
C103	Site Geometric Plan
C104	Site Grading and Utility Plan
C105	Site Erosion Control Plan
C106	Site Typical Finished Section
C107	Site Plan and Profile
C108	Site Details
C109	Site Details
C110	Site Details
C111	Site Details
	Architectural Drawings
A100	Demolition Floor Plan
A200	Floor Plan
A420	Building Section & Wall Sections
A600	Interior Elevations
A670	Detail
A671	Sign Elevations
	Structural Drawings
S001	General Structural Notes and Abbreviations
S200	Partial Plans
S201	Typical Sections and Details
S202	Sections and Details
S203	Section and Details
	Plumbing Drawings
P001	Plumbing Symbols, Abbreviations, Details & Schedules
P100	Underslab Plumbing Demo Plan
P101	First Floor Plumbing Demo Plan
P200	Underslab Plumbing Plan
P201	First Floor Plumbing Plan

Mechanical Drawings

M100	First Floor Mechanical Demo Plan
M200	First Floor Mechanical Plan
M400	First Floor Section
M800	Equipment Schedules
N200	Mechanical Site Plan
N201	Process Areas
N400	Compressed NG P&ID Diagram
N401	Compressed NGP&ID Diagram
N500	Process NG Time Fill Area
N600	Structural And Process Standard Details
N601	Process Safety Details

Electrical Drawings

E000	Electrical Symbols, Abbreviations and General Notes
E010	Electrical One-Line Diagram
E020	Overall Electrical Site Plan
E030	Site Lighting Calculations
E100	Service Garage Demolition Plan
E201	Service Garage Lighting Plan
E301	Service Garage Power Plan
E401	Service Garage Systems Plan
E600	Process Areas and Details – Electrical
E601	Electrical Hazardous Location Legend

END OF DRAWING LIST

SECTION 00900: GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSIS

The information included in this Section is for informational purposes only and is for the convenience of the bidders in preparation of their bids and the contractor in the performance of the work.

Data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. It is expressly understood that the owner will not be responsible for interpretations or conclusions drawn therefrom by the contractor. Additional test borings and other exploratory operations may be made by the contractor at his option at no cost to the Owner.

GEOTECHNICAL ENGINEERING REPORT

NW Garage Compressed
Natural Gas Fueling Station
Milwaukee, Wisconsin

GESTRA Project No.: 13012-10
March 25, 2013

Prepared For:
The Sigma Group
Milwaukee, WI

GESTRA

Geotechnical Engineering Report

NW Garage Compressed Natural Gas Fueling Station
Milwaukee, Wisconsin

GESTRA Project No.: 13012-10
March 25, 2013

Prepared for:

The SIGMA Group
1300 West Canal Street
Milwaukee, WI 53233

Report Prepared by:

GESTRA Engineering, Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205

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Geotechnical Engineering Report

NW Garage Compressed Natural Gas Fueling Station
Milwaukee, Wisconsin

GESTRA Project No.: 13012-10
March 25, 2013

1.0 INTRODUCTION

GESTRA Engineering, Inc. (GESTRA) was authorized by The SIGMA Group (SIGMA) to complete a subsurface exploration and geotechnical investigation for the proposed NW Garage Compressed Natural Gas Fueling Station project located in Milwaukee, Wisconsin. This report presents the results from the subsurface soil exploration and describes the field exploration, laboratory test results, and provides recommendations pertaining to the design and construction of the proposed building renovation and a new natural gas fueling station with cul-de-sac road and bio retention area.

The engineering recommendations and analysis contained within this report are based on the following project information which is a projection of GESTRA's understanding of the project. If for any reason the actual project information differs from what is reported below, GESTRA should be contacted so that we can review our recommendations in light of any new information.

1.1 Project Information

The existing City of Milwaukee, Department of Public Works, NW Garage is located at 3020/3021 W. Ruby Avenue in Milwaukee, Wisconsin. The proposed project consists of a renovation to a portion of the interior of the existing garage building to add four service bays for vehicle maintenance and new construction of a natural gas fueling station with cul-de-sac road encircling a bio retention basin at the southeast corner of the property.

The new service bays will be constructed with interior masonry partition walls that support small mechanical mezzanines constructed with concrete slab on metal deck. The maximum anticipated interior wall load will be 5 kips per lineal foot and we assume the foundation bearing elevation will be approximately 2 feet or deeper below the existing slab elevation.

The fueling station consists of a fuel dispensing unit and associated tanks with a canopy to protect user from the weather. The maximum anticipated load for the storage tanks will be 2,000 pounds per square foot (psf) and the tanks will be supported on a concrete pad with a shallow perimeter foundation or thickened edges. The canopy column load will not exceed 30 kips and we assume the foundation bearing elevation will be approximately 5 feet below the existing grade.

We understand the base of the bio retention basin is currently designed for elevation 65.5 feet City of Milwaukee Datum (CMD). The pond will be lined with a rubber membrane to prevent infiltration into the existing subsurface.

2.0 SCOPE OF WORK

GESTRA has performed the following services for the project:

1. Provided layout of the borings at the project site using tape and stake methods referenced to known site locations. Obtained survey information for boring locations after drilling from SIGMA.
2. Contacted Diggers Hotline to identify the utility locations prior to drilling. Contacted Private Lines to locate private utility lines not located through Diggers Hotline near boring locations on property.
3. Performed three (3) standard penetration test (SPT) borings. One boring (B-1) was located within the existing building in the area of the new masonry walls and 2 borings (B-2 and B-3) were located near the southeast corner of the property in the area of the fueling station and bio retention basin. Borings were performed using a truck mounted drilling rig. Boring B-1 was drilled to a depth of 25 feet and sampled at 2 ½ foot intervals to 10 feet and 5 feet thereafter. Borings B-2 and B-3 were drilled to depths of 20 feet to 26 feet, respectively and sampled continuously to the depth of the boring
4. Installed 3 monitoring wells at the project site for SIGMA to develop and monitor. One well was installed within the existing building within boring B-1 (MW-1), one at the location of the bio retention basin within boring B-3 (MW-3), and one near the northwest corner of the property (MW-2).
5. Abandoned the boreholes, without wells, with bentonite chips per WDNR requirements.
6. Performed laboratory soil testing to assign classification and engineering properties to the soils encountered. The laboratory testing included hand penetrometer, Atterberg limits, gradation, and moisture contents.
7. Prepared this engineering report presenting the results of the field exploration, laboratory testing, and providing the following recommendations pertaining to proposed construction.
    a. Building/Fueling Station - allowable soil bearing capacity and estimates of settlement for spread footing foundations, seismic site classification, anticipation and management of groundwater, subgrade modulus for design of slabs on grade, lateral earth pressures in equivalent fluid pressure, OSHA soil type for excavation purposes, and site preparation/soil correction.
    b. Pavement – soil parameters for the pavement design consisting of an estimated CBR value, site preparation/soil correction recommendations, compaction recommendations for support of pavements, asphalt and base course thickness for the proposed parking lots and drive lanes based on assumed traffic counts.
    c. Bio Retention Basin - Classified the soils collected per the USCS system and the Field Book for Describing and Sampling Soils, USDA, NRCS, 1998.

3.0 EXPLORATION RESULTS

3.1 Site Conditions

The existing garage and parking areas are located on the northern half of the site, and the southern half of the property is vacant with grass cover. Existing elevations at boring locations were: B-2 656.7 feet (76.1 feet CMD), B-3 654.5 feet (73.9 feet CMD), and B-1 660.1 feet (79.5 feet CMD). The site has an overall decrease in elevation from the location of the existing building to the southern portion of the property.

3.2 Subsurface Soil Profile

At boring location B-1, an approximate 7 inch thick concrete floor slab was encountered at the surface with base material below the slab to a depth of 10 inches. Below the concrete and base material, very stiff lean clay was encountered to an approximate depth of 12 feet below ground surface (bgs). Samples of the very stiff lean clay layer had moisture contents ranging between 17% to 31%, and with hand penetrometers readings of 2.0 tsf to 4.5+ tsf. An unconfined compressive strength test was performed on sample of soil from in this layer with a strength of 2.3 tsf.

Below the very stiff lean clay layer in B-1, medium stiff to stiff lean clay was encountered to an approximate depth of 23 feet. Samples of the lean clay layer had moisture contents ranging between 20% and 30% with hand penetrometer readings of 0.5 tsf to 1.25 tsf. Possible weathered bedrock was encountered at a depth of 23 feet to the termination of the boring at 25 feet.

At boring locations B-2 and B-3, topsoil was encountered at the ground surface to a depth of 7 inches to 8 inches. Fill material which consisted of lean clay with sand, trace gravel was encountered below the topsoil to a depth of 5.5 feet and 6 feet in borings B-2 and B-3, respectively. The observed fill material SPT N-values ranged from 10 to 13 and moisture contents of samples ranged from 14% to 29 %.

Stiff to very stiff lean/fat clay was encountered below the fill material to an approximate depth of 15 feet bgs. Moisture contents of samples tested ranged from 21% to 25% with hand penetrometer readings of 2.0 to 4.5+ tsf. Stiff to very stiff lean to silty clay with to trace sand and gravel was encountered below the above clay layer to the 20 feet and 26 feet termination depths of the borings B-2 and B-3, respectively. Moisture contents ranged from 12% to 16 % with hand penetrometer readings ranging between 1.0 and 4.0 tsf.

Results of the field and laboratory tests and observations are depicted on the individual test boring logs included in Appendix I of this report. Soils were grouped together based on similar observed properties. The stratification lines were estimated by the reviewing engineer based on the available data and experience. The actual in-situ changes between layers may differ slightly and may be more gradual than depicted on the boring logs. Subsurface and groundwater conditions can vary between borehole locations and in areas not explored.

3.3 Groundwater Observations

Groundwater was not encountered at the time of drilling or completion of drilling at any of the boring locations. Three monitoring wells were installed at the request of SIGMA. GESTRA did not develop the wells or record any water level measurements from the wells at the time of

installation. The information in the table below are water level measurements provided from SIGMA on March 25th, 2013. Well location MW-1 was dry at the date of monitoring.

Table 3-1: Groundwater Measurements

Well Locations	Groundwater During Drilling (ft.)	
	Elevation (ft)	Elevation CMD (ft)
MW-1	--	--
MW-2	638.3	57.7
MW-3	635.5	54.9

Based on the coloration of the soils encountered in our borings and the above water level measurements, we estimate the groundwater level around elevation 640 to 643 feet (59 to 62 feet CMD). Groundwater level fluctuations may occur with time and seasonal changes due to variations in precipitation, evaporation, surface water runoff and local dewatering. Perched water pockets and a higher water table may also be encountered during wet weather periods, particularly in more permeable silt and sand seams or granular fill material overlying less permeable soils.

4.0 ANALYSIS AND RECOMMENDATIONS

4.1 Site Preparation

Site preparation should start with removal of any surficial organic soils, debris or other deleterious material. In addition, all unused utilities should be properly removed or abandoned. Within the existing building, the existing construction should be completely removed from below proposed foundations. Material removed from the project site should be disposed in accordance with all applicable federal, state, and local regulations. Soil should not be stockpiled near or adjacent to the excavations. Additional site preparation recommendations for foundations, pavements and slab on grade are provided in subsequent sections.

In the proposed pavement areas and slab on grade areas (interior or exterior) after the initial site preparation, a proof roll should be performed with a minimum 20 ton tri-axial dump truck, or like machinery imparting similar static loading on the soil and moving at no more than walking speed. A geotechnical engineer or their designated representative should be present during the proof roll in order to identify soft or unstable areas, if any, and subsequently recommend remediation procedures. If instability is observed, these areas could be disked, dried, and re-compacted if weather permits, or removed and replaced with engineered fill. Assuming these site preparation measures are followed, the observed inorganic sandy or clayey fill material may be left in place below future pavement areas.

As a general rule for new fill placement, the lift thickness should not exceed 12 inches for granular soils and 9 inches for cohesive soils and the maximum particle size should be limited to 25% of the lift thickness. Engineered fill placed within the building pad, below foundations or in the pavement subgrade/base course should be compacted to a minimum of 95% of the Modified Proctor dry density value. Structural soil fill should be placed a minimum of five feet beyond the edges of the new buildings/pavements, and an additional foot horizontally for each vertical foot of new fill to be placed to provide adequate lateral confinement. The inorganic site soils free of

any construction debris that would be removed from excavations could be reused as structural fill; however, moisture conditioning of the material may be necessary.

4.2 Foundation Recommendations

Based on the results of our exploration, the existing inorganic native clay at the building and canopy locations should be suitable for a shallow spread foundation designed for a maximum net allowable soil bearing pressure of 3,000 psf provided the recommendations in this report are followed. We do not recommend bearing spread foundations within or above the existing fill. Table 4-1 provides approximate depths to the soil recommended for a design allowable bearing capacity of 3,000 at each of the test boring locations performed.

Table 4-1: Approximate Bearing Capacity Depths

Test Boring Location	Existing Ground Elevation (ft)	Approximate Depth to 3,000 psf Allowable Bearing Capacity (ft)		Soil Description
		Depth (ft)	Elevation (ft)	
B-1	660.1	2	658.1	Lean clay
B-2	656.7	5.5	651.2	Lean/Fat clay
B-3	654.5	6	648.5	Lean/Fat clay

*Depth is estimated based on samples collected; however, exact transition of fill and native soil may vary throughout the site.

Where unsuitable soils are encountered at the foundation elevation, soil correction should consist of additional excavation to remove the unsuitable soils. If the over-excavation is being filled with engineered fill, we recommend the over-excavation be widened at a minimum 1H:1V ratio from the edge of the foundation. The over-excavation can then be filled to grade with suitable engineered fill placed in lifts not exceeding 12 inches and compacted to at least 95% of the Modified Proctor density (ASTM D1557). Alternatively, lean concrete with a minimum compressive strength of 500 psi could be used to fill the over-excavation to grade and lateral over-excavation will not be required.

The depth of excavation required to expose suitable bearing material may vary in areas not explored by GESTRA; therefore, we recommend the foundation excavations be reviewed by a geotechnical engineer or their designated representative to determine when soils suitable to support the recommended bearing capacity are observed.

The shallow foundation design should incorporate a minimum strip footing width of 18 inches and minimum column pad width of 24 inches, even if the allowable bearing capacity has not been fully utilized. All perimeter foundations for heated structures should bear a minimum of 42 inches below grade and foundations for unheated structure should bear a minimum of 48 inches below grade in order to protect the structure from frost heave. We recommend that foundations also be suitably reinforced in order to compensate for the effects of minor differential movements due to subsurface soil variations. If the recommendations as stated in this report are used in the design and construction of the proposed buildings, it is our opinion that total settlements will be less than 1 inch.

4.3 Below Grade Earth Pressures

If below grade walls are designed the walls will need to be designed to resist lateral earth pressures. The values presented in the following Table 4-2 assume that the walls are vertical; that a clean, free-draining granular fill is used as backfill within 2 feet behind the wall; the backfill condition at the ground surface is level; and that adequate drainage is provided to prevent the buildup of any hydrostatic pressure. In addition, the below grade walls will also be required to resist the surcharge of traffic that may occur during or after construction.

Table 4-2: Estimated Lateral Earth Pressure Coefficients

Soil Description	Unit Weight (pcf)	Internal Friction Angle Φ	At-Rest Earth Pressure Coefficient, (K_o)	Active Earth Pressure Coefficient, (K_a)	Passive Earth Pressure Coefficient, (K_p)
Existing Fill / medium stiff to stiff Lean Clay	130	28	0.53	0.36	2.77
V. Stiff Lean Clay	130	30	0.5	0.33	3.00

For walls that are free to rotate at least 0.001 times the height of the wall, such as a temporary earth retention system and retaining walls, then an active earth pressure condition will develop. For walls that will be restrained, such as permanent basement walls, then an at-rest condition will pertain. Equivalent fluid densities can be calculated by multiplying unit weight by the listed pressure coefficients at different conditions. The upper 1-foot of soil and frozen soils should be ignored when calculating passive resistance.

For permanent below grade walls, drainage should be provided behind the below-grade walls to prevent the buildup of hydrostatic pressures. We recommend that free-draining granular drainage aggregate, such as ASTM Specification C33 Size No.67 washed concrete aggregate, be placed within 2 feet behind the back face of the below grade walls. Drainage pipes should also be installed along the perimeter of below-grade walls, slightly above the footing, and allowed to drain either by gravity or to a sump pit and pump system. The drainage pipes should be surrounded by a minimum of 6 inches of drainage aggregate. Due to the existing soils containing a percentage of fine material, the drainage aggregate should be completely wrapped in a non-woven, high survivability, geotextile fabric with an apparent opening size (AOS) in the range of 70 to 100. The geotextile fabric should prevent migration of any adjacent soil into the drainage aggregate. The drain pipes should be supplied both inside and outside of the building footings, and be interconnected through the footing at 15 to 20 feet on center. We do not recommend using a drainage pipe that includes a geotextile sleeve in immediate contact with the pipe as an alternate to our recommendations.

We recommend a relatively impermeable barrier that may consist of a minimum 2 foot thick clay cap or Bituminous or Portland cement concrete (i.e. walkways and drives) be placed around each of the below-grade structures to minimize surface water infiltration into the backfill against the walls. The clay material, if used, should be placed and compacted as recommended in this report

and should extend from final grade to a depth of at least 2 feet. The clay cap or impermeable barrier should slope away from the structure at a minimum 2 percent grade. Surcharge loads, including those from adjacent (present and future) structures, as well as temporary construction equipment, within a zone defined by a plane extending at a 45 degree angle above the base of the wall should also be included in the design. The size of the compactor used behind the wall should be limited to less than 500 pounds to minimize stresses on the wall; however, maximum stresses allowed on the wall should be determined by the project structural engineer. The backfill should be compacted to a minimum of 90 percent of the maximum dry density as determined by the modified Proctor test, ASTM D-1557.

4.4 Slab Recommendations

The subgrade material evaluated and prepared according to the recommendations in this report should be suitable to support slab on grade concrete. We recommend that a subgrade reaction modulus of 125 pounds per square inch per inch of deflection (pci) be used in the design of the floor slab at grade. The modulus value was assumed based on the soils encountered at the anticipated subgrade elevation and our experience with similar subgrade conditions. This value assumes a 1 foot plate is used to determine the modulus and should be adjusted for the size of the foundation and confinement effect. We recommend that the floor slabs be suitably reinforced and designed to be separate from the foundation system in order to allow for separate movements. A proof roll of at grade slab areas should be completed to evaluate the subgrade soils prior to slab base material placement.

To reduce the effects of curling, we recommend the installation of a capillary moisture break placed directly below the slab. It should consist of at least 6 inches of clean sand or gravel containing no more than 5% passing the number 200 sieve (fines). If the floor slab is to include floor coverings, we recommend that the manufacturer should be consulted to verify the proper incorporation of a vapor retarder. If a vapor retarder is used, it should be placed directly below the slab and should meet the requirements of ASTM E1745. The vapor retarder should include proper sealing at penetrations, overlap at joints, and sealing at the interface of the wall and slab and may require an adequate cushion material to prevent damage.

4.5 Pavement Design Recommendations

The Wisconsin Asphalt Pavement Association (WAPA) and the results of the geotechnical evaluation were used to provide the following recommendations. The subgrade soil directly below the topsoil in the area of borings B-2 and B-3 consisted predominately of lean clay fill. Based on this material as the subgrade soil, GESTRA recommends that “poor soils” should be assumed as the subgrade soils.

At this time, the anticipated traffic volume is not available. Based on the anticipated site use, GESTRA is assuming the following traffic classes to determine the pavement section recommendations meeting the minimum of a 10-year life expectancy.

- Traffic Class III: Light industrial lots, collector streets and other roadways with a Design Daily ESALs range of 6 to 50 (18,000 pound equivalent single axle loads).
- Traffic Class IV: Local business streets and medium industrial streets/lots with a Design Daily ESALs range of 51 to 275.

Table 4-3: Pavement Design Recommendations

Traffic Class	Pavement Layer Type	Thickness, inches	Material Type
		Drive Lanes and Drive Thru	
III	Hot Mix Asphalt	6.0	HMA Mix E-0.3 (ESALs <41) or E-1 (ESALs≥41)
	Base Course (Dense Graded)	10.0	WisDOT Specification Section 305
IV	Hot Mix Asphalt	8.0	HMA Mix E-3
	Base Course (Dense Graded)	14.0	WisDOT Specification Section 305

Pavement sections presented in Table 4-2 should not be used for areas that will see heavy truck loading, equipment or truck parking areas, or entrances and exit aprons. In these areas, a Portland Cement Concrete pavement should be used. This may include such high loading areas as the fueling station apron or a trash dumpster loading zone. The PCC layer thickness is recommended to be 6.0 inches with a minimum of 6.0 inch-thick crushed stone base course, but may be modified depending on the final design. The reinforcement details, as needed, for PCC pavement section should be designed by the project design engineer as the project conditions dictate.

All pavements require regular maintenance and repair in order to maintain the serviceability of the pavement. These repairs and maintenance are due to normal wear and tear of the pavement surface and are required in order to extend the serviceability life of the pavement. However, after 10 years of service, a normal pavement structure is likely to deteriorate to a point where pavement rehabilitation may be required to maintain the serviceability.

4.6 Seismic Site Classification

Section 1615 of the International Building Code 2009 (IBC) was used to assign a soil site classification. Based on the native soil conditions observed and assuming these are consistent or better to a depth of 100 feet, the soil site classification **D** (stiff soil) should be used in the structural design of the proposed building. Based on site class D, and mapped spectral response acceleration S_s and S_1 for Milwaukee, WI, the site coefficient F_a and F_v are 1.6 and 2.4, respectively.

4.7 Bio Retention Basin

As part of the requested scope of services for this project, GESTRA classified the soils collected from borings B-2 and B-3 per the Field Book for Describing and Sampling Soils, USDA, NRCS, 1998. It is our understanding that the bio retention basin will be lined to prevent infiltration of water into the subsurface. If the design changes and infiltration is to be performed at the site,

GESTRA can provide recommendations for a design infiltration rate based on the soils encountered.

Groundwater was not observed in our borings during or at the completion of drilling. Water level measurements 17 days after well installation varied from elevations 635.5 feet (54.9 feet CMD) to 638.3 feet (57.7 feet CMD). Therefore, significant groundwater is not anticipated to be encountered at the depth of the bio retention basin excavation.

4.8 Soil Corrosivity

One soil sample from 6 to 8 feet below ground surface near the fueling station location was tested for resistivity following the general procedures of ASTM G57 (Standard Test Method for Field/Lab Measurement of Soil Resistivity Using the Wenner Four-Electrode Method). The following table provides a summary of the test results and the detailed chemical test results are included in the Appendix II.

Table 4-4: Summary of Laboratory Test for Soil Corrosivity

Sample Location and Number.	Resistivity Value
B-2, SS-4 (6-8 feet)	1,840 ohm-cm

Based on the Steel tank Institute Recommend Practice for Corrosion Protection of Underground Piping Networks (R892-91), a generally accepted corrosivity index for soil according to resistivity is:

Very corrosive	Under 1,840 ohm-cm
Aggressive	1,000 to 5,000 ohm-cm
Mildly corrosive	5,000 to 10,000 ohm-cm
Slightly corrosive	10,000 to 25,000 ohm-cm
Progressively less corrosive	Over 25,000 ohm-cm

4.9 Construction Consideration

The detailed means and method of excavation and construction should be decided by the contractor and approved by the project design team. Based on the specific site information, geotechnical exploration results and requirements for the proposed structures, the following issues should be taken in consideration during construction.

Dewatering

Based on the water level measurements performed as part of the project exploration, presence of free water is not expected at shallow excavation depth within the existing building or the estimated 10 feet excavation depth in the bio retention area. Water from other sources such as

surface runoff from rain events or water trapped in existing utility trenches could enter into excavations. Perched or trapped water within or above the existing fill also may be encountered in the excavations. If water is encountered during excavation, an appropriate number of temporary sump pits and pump should be sufficient to remove anticipated volume of water in the excavation. If rapid seepage occurs in deep excavations, a deeper sump, well points or sheeting may be required to control water seepage.

Excavation Stability

Caving is a common issue for excavation side walls during construction, especially if granular soils are observed. An excavation plan should be developed and the length of excavation left open should be limited to prevent caving soil from covering the suitable bearing soils. The contractor must comply with the federal, state, local and updated OSHA regulations during excavation and in retention system design to ensure excavation safety.

Occupational Safety and Health Act (OSHA) has instituted strict standards for temporary construction excavations. These standards are outlined in 29 CFR Part 1926 Subpart P. Excavations within unstable soil conditions or extending five feet or more in depth should be adequately sloped or braced according to these standards. Excavation safety is the responsibility of the contractor. Based on the soil boring data, we expect that a large portion of the excavations will be completed within cohesive fill soils. These soils are classified as Type B within the OSHA regulations. Material stockpiles or heavy equipment should not be placed near the edge of the excavation slopes. The actual stable slope angle should be determined during construction and will depend upon the loading, soil, and groundwater conditions encountered.

Weather Implications

The subgrade soil or the soil at foundation level might become unstable with exposure to adverse weather such as rain, snow and freezing temperatures. The unstable areas due to weather exposure may require an additional undercut or stabilization and the representative geotechnical engineer should assist with the determination of the depth of additional undercut or stabilization procedure based on observation of the field condition.

Soil Sensitivity

Soil at the construction site will be exposed to moisture and disturbance from construction traffic, construction equipment and human factors. Due to the disturbance, soil may become sensitive with contact of water. Contractor should try to lessen the exposure the soil at the construction site may encounter to moisture and disturbances. Therefore, foundations, floor slabs and pavements should be constructed immediately after the review of the representative geotechnical engineer.

5.0 EXPLORATION AND TESTING PROCEDURES

5.1 Layout and Elevation Procedures

A total of three (3) soil borings were completed at the locations shown on the attached Borehole Location Map in Appendix I. Monitoring wells were installed in two boring locations and a third monitoring well was installed at another location in a blind drilled boring. The location of each of the borings was selected by the project design team and GESTRA located the borings in the field using tape and stake methods referenced to known site features. SIGMA provided the

ground surface elevation for each borehole location. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to obtain them.

5.2 Field Testing Procedures

All of the boreholes were drilled using a truck mounted drill rig. The boreholes were initiated and advanced by using 3-1/4 inch hollow stem augers. All representative soil samples were taken in general accordance with the "Standard Method for Penetration Test and Split-Barrel Sampling of Soils" (ASTM D1586). After each sampling, a soil sample was retained and placed in a jar and recorded for type, color, consistency, and moisture, sealed and then transported to the laboratory for further review and testing, if required. The specific drilling method used including the depths, rig type, crew chief, are included on each of the individual boring logs as it may change for each borehole.

5.3 Laboratory Testing Procedures

After completion of drilling operations, all of the retained soil samples were transported to GESTRA's laboratory and classified by a geotechnical engineer using the Unified Soil Classification System. A chart describing the classification system used is included in the Appendix I of this report. The engineer then assigned laboratory testing suited to extract important index properties of the soil layers. These tests included moisture contents, hand penetrometer, sieve analysis, unconfined compressive strength, and soil resistivity. All lab results are presented in Appendix II of this report.

Moisture Content (ASTM D2216)

The moisture content of a soil is the percentage of the weight of water or "moisture" in a soil to the total weight of organics and dry soil together. This value is a valuable index property in clays and organic soils and is sometimes used in conjunction with other index properties to approximate settlement of a soil layer. Moisture contents have been known to vary in stiff clays from 10% to 18% and from 20% to 150% in soft clays. Peat soils which are highly organic can have moisture contents in excess of 300%.

Mechanical Analysis and Hydrometer (ASTM C136 and D422)

This test is usually chosen by the geotechnical engineer when the percentage of material passing the #200 sieve or "fine content" is of particular importance. In general, the material is broken down into individual sizes and weighed to determine the percentage of the soil retained and passing a certain sieve size. In a geotechnical project, the fine content is correlated to the frost susceptibility of a soil and can provide us with important information pertaining to the stability of the soil during construction. In the case of aggregates, these values can be compared to state and municipal specifications to determine if the material is suitable for use as an engineered fill.

Atterberg Limits (ASTM D4318)

Three values are obtained by completing the Atterberg Limits: the liquid limit, plastic limit, and plasticity index. The liquid limit is performed by obtaining a clayey or silty specimen which has been dried and ground to pass through a #40 sieve and adding water to make a "mud". This mud is then placed in a liquid limit machine and subjected to blow counts which are recorded. The "moisture" of the mud is then varied 2 more times in order to chart the relationship between blow

counts and moisture content. The moisture content of the soil at 25 blows is referred to as the "liquid limit" of the soil.

The plastic limit is performed by again using the same soil that has passed through #40 sieve and water has been added to it. However, the moisture content of this soil is kept lower than before. The soil will form a ball which is rolled into "worms" of soil. When cracking is observed in the skin of the worm at 1/8" diameter, the moisture content of the soil at this point is the "plastic limit". The plasticity index is the difference between the liquid limit and the plastic limit.

Unconfined Compressive Strength Test (ASTM D2166)

The unconfined compression strength is the compressive stress at which an unconfined cylindrical soil specimen fails in a simple compression test. This test is completed by imparting an axial load to a clayey soil at a specified rate until the sample deforms at least 15% of its original length or fails by fissure. The maximum load applied to the sample is then divided by the area of the sample to obtain the unconfined compressive strength of the soil. The cohesion of the soil is calculated to be one-half of the compressive stress at failure. This value is often used in calculating soil bearing capacity.

STANDARD OF CARE

Our exploration was limited to evaluating subsurface soil and groundwater conditions pertaining to the proposed project. GESTRA did not perform any environmental, chemical, or hydrogeologic testing as these were not part of our work scope.

This report should be made available in its entirety to bidding contractors for information purposes. The soil borings and site sketch should not be detached from this report. Our report is not valid if used for purposes other than what is described in the report.

All OSHA regulations such as those regarding proper sloping and temporary shoring of excavations should be followed during the entire construction process.

GESTRA has presented our professional opinions in this report in the form of recommendations. Our opinions are based on our understanding of current project information and related accepted engineering practices at the time of this report. Other than this, no warranty is implied or intended.

Sincerely,

Gestra Engineering, Inc.

Report Prepared By:

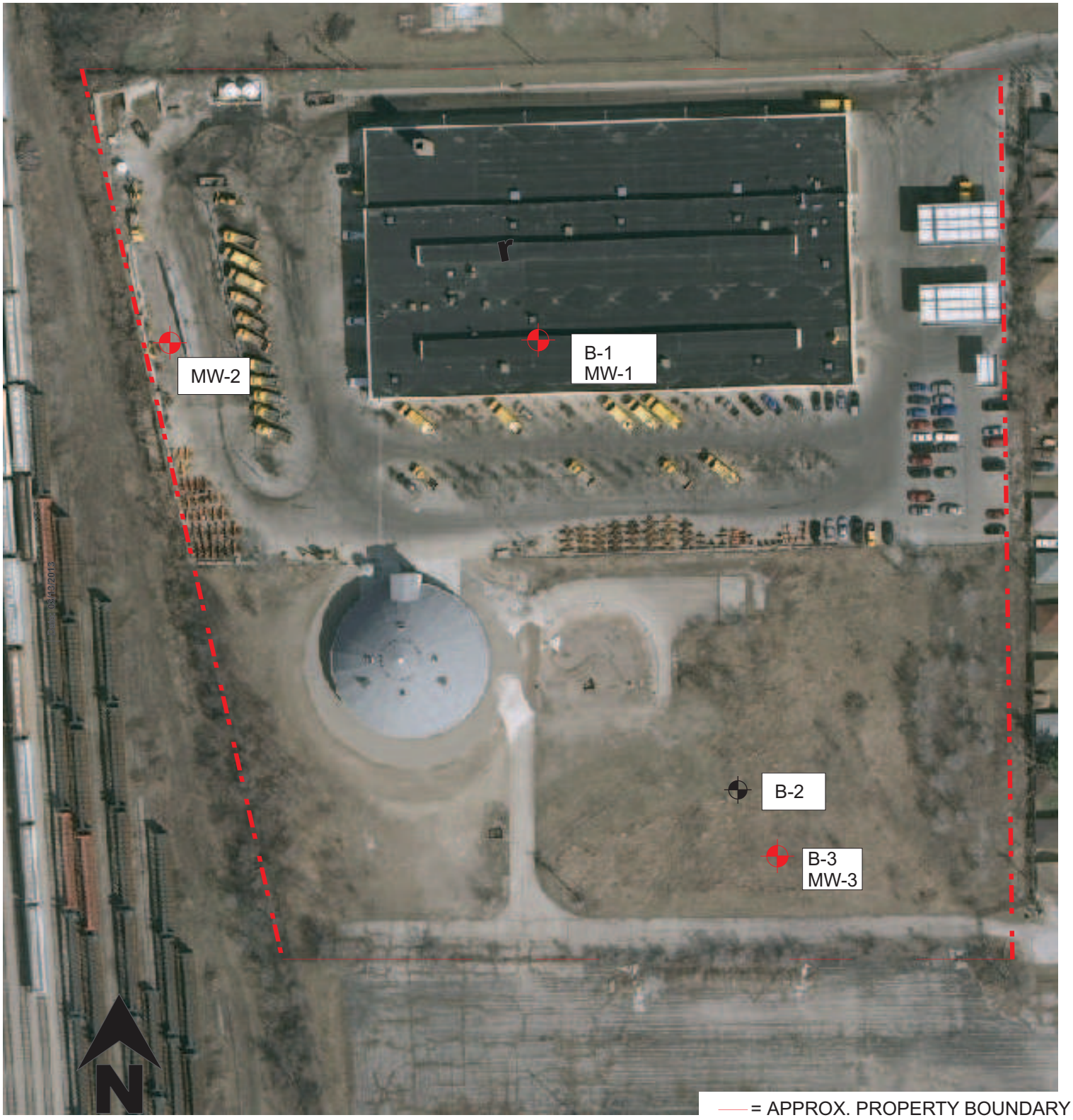
Ryan English, EIT
Staff Engineer

Report Reviewed By:

Douglas Dettmers, P.E.
Senior Engineer

APPENDIX I

BORING LOCATION PLAN, TEST BORING LOGS,
WELL CONSTRUCTION LOGS AND NOMENCLATURE



GESTRA Engineering, Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53202
Phone: (414) 933-7444
Fax: (414) 933-7844

Project Name & Location:
NW Garage Compressed Natural Gas Fueling Station
Milwaukee, WI

Drawing Title:
Borehole Location Map

Project No.: 13012-10

Scale: NOT TO SCALE

Drawing No.: 1 of 1

Drawn by: RHE

Checked by: DD

Date: March 25, 2013

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: NW Garage CNG Fueling Station		DATE DRILLING STARTED: 3/7/2013	PAGE NUMBER: 1 of 1
PROJECT LOCATION: Milwaukee, WI		DATE DRILLING ENDED: 3/7/2013	BORING NUMBER: B-1
BORING DRILLED BY: FIRM: Gestra; CREW CHIEF: A. Woerpel	FIELD LOG: D. Born	NORTHING	PROJECT NUMBER: 13012-10
	LAB LOG / QC: R. English	EASTING	DRILLING RIG: CME 45
			DRILLING METHOD: 3¼" HSA
			SURFACE ELEVATION: 660.1 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
						CONCRETE, (7 inches)								Boring located 5 ft South and 9 ft West from Repair shop SE corner. No groundwater observed during drilling. 2 inch well installed and set at 25 ft depth.
						0.6 (659.5)	GP							
SS - 1	15	4 9 15	24			BASE MATERIAL, GRAVEL (3 inches) 0.8 (659.3) LEAN CLAY, brown with gray mottling, moist, very stiff to hard	CL			4.5+			17	
SS - 2	16	4 9 15	24	5	655.1					2.25			21	
						5.5 (654.6)								
SS - 3	18	4 7 9	16			LEAN CLAY, light brown and gray, moist, very stiff, with silt lenses				4.0			24	
SS - 4	18	3 3 5	8	10	650.1		CL			2.0 **(2.3)**			31	γ_d = 101.4 pcf γ_T = 126.1 pcf
						12 (648.1)								
						LEAN CLAY, brownish gray, moist, medium stiff to stiff								
SS - 5	18	2 3 5	8	15	645.1					1.25			30	
							CL							
SS - 6	18	2 4 5	9	20	640.1					0.5-1.0			20	
						23 (637.1)								
						POSSIBLE WEATHERED BEDROCK, DOLOMITE								
SS - 7	1	50/0"	50/0"	25	635.1	25 (635.1) Rock fragments observed in SS-7 End of Boring at 25.0 ft.								
				30	630.1									

WATER & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: NE	CAVE DEPTH AT COMPLETION: N/A		WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: NE	CAVE DEPTH AFTER 0 HOURS: N/A		WET ☐ DRY ☐
▼	WATER LEVEL AFTER 0 HOURS: NE	NE = Not Encountered; NMR = No Measurement Recorded		

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

GESTRA
Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: NW Garage CNG Fueling Station		DATE DRILLING STARTED: 3/8/2013	PAGE NUMBER: 1 of 1
PROJECT LOCATION: Milwaukee, WI		DATE DRILLING ENDED: 3/8/2013	BORING NUMBER: B-2
BORING DRILLED BY: FIRM: Gestra CREW CHIEF: A. Woerpel	FIELD LOG: J. Bruesewitz LAB LOG / QC: R. English	NORTHING: 406707 EASTING: 2515476	PROJECT NUMBER: 13012-10 DRILLING RIG: CME 45 DRILLING METHOD: 3¼" HSA SURFACE ELEVATION: 656.7 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
SS - 1	16	4 4 5 6	9			TOPSOIL (7 inches) 0.6 (656.1) FILL, LEAN CLAY WITH SAND, brown, moist, trace to with gravel							41	LOI= 10.5% MC(CL)= 20.5% Groundwater not encountered during drilling. 8 inches of frost observed at time of drilling.
SS - 2	16	4 7 5 7	12								43	18	14	
SS - 3	6	5 8 5 7	13	5	651.7	5.5 (651.2) LEAN CLAY, brown, moist, very stiff to hard							22	
SS - 4	6	4 4 4 8	8							2.0			23	
SS - 5	24	5 7 13 15	20	10	646.7		CL			4.5+			23	
SS - 6	18	3 4 7 9	11							4.5			25	
SS - 7	24	3 5 7 9	12			13 (643.7) SIILTY CLAY WITH GRAVEL, dark brown, moist, stiff	CL-ML			2.0			16	
SS - 8	24	4 5 6 9	11	15	641.7	14 (642.7) LEAN CLAY WITH SAND, light brown and gray, moist, very stiff, trace gravel 16 (640.7)	CL			3.25			15	
SS - 9	24	5 7 11 17	18			LEAN TO SILTY CLAY, light brown to gray, moist, stiff to very stiff, with sand lenses	CL			4.0			12	
SS - 10	24	5 6 6 9	12	20	636.7	20 (636.7)				1.5-2.5			15	
						End of Boring at 20.0 ft.								
				25	631.7									
				30	626.7									

WATER & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: NE	▨	CAVE DEPTH AT COMPLETION: NE	WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: NE	■	CAVE DEPTH AFTER 0 HOURS: NE	WET ☐ DRY ☐
▼	WATER LEVEL AFTER 0 HOURS: NE		NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

SOIL BORING LOG

Gestra Engineering Inc.
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: 414-933-7444, Fax: 414-933-7844

PROJECT NAME: NW Garage CNG Fueling Station		DATE DRILLING STARTED: 3/8/2013	PAGE NUMBER: 1 of 1
PROJECT LOCATION: Milwaukee, WI		DATE DRILLING ENDED: 3/8/2013	BORING NUMBER: B-3
BORING DRILLED BY: FIRM: Gestra; CREW CHIEF: A. Woerpel	FIELD LOG: J. Bruesewitz	NORTHING: 406655	PROJECT NUMBER: 13012-10
	LAB LOG / QC: R. English	EASTING: 2515507	DRILLING RIG: CME 45
			DRILLING METHOD: 3¼" HSA
			SURFACE ELEVATION: 654.5 ft

Number and Type	Recovery (in)	Blow Counts	N - Value	Depth (ft)	Elevation	Soil Description and Geological Origin for Each Major Unit	USCS Classification	Graphic	Well Diagram	Unconfined Comp. Strength (Q_u, or Q_p) (tsf)	Liquid Limit	Plasticity Index	Moisture Content (%)	Comments
SS - 1	18	4 10 8 8	18			TOPSOIL (8 inches) 0.7 (653.8) FILL, FOUNDARY SAND, black 1.4 (653.1)							27	Groundwater not encountered during drilling. Installed 2" well and set at 24 ft depth. 8 inches of frost observed at time of drilling.
SS - 2	12	3 3 7 9	10			FILL, LEAN CLAY, grayish brown to reddish brown, moist				2.5			29	
SS - 3	16	2 5 6 10	11	5	649.5	6 (648.5)				1.5			26	
SS - 4	20	4 10 17 19	27			FAT CLAY, light brown, moist, very stiff to hard				4.5+			21	P200= 99.7%
SS - 5	19	4 6 10 11	16	10	644.5					4.25	53	18	23	
SS - 6	24	4 6 9 12	15			Trace gravel obsreved in SS-6	CH			2.0-4.5+			24	
SS - 7	24	3 5 8 10	13			Trace to with sand observed in SS-7				3.25			22	
SS - 8	0	13 17 16 17	33	15	639.5	15 (639.5)								
SS - 9	18	3 8 7 9	15			LEAN CLAY, gray, moist, stiff to very stiff, trace sand and gravel				2.25			14	
SS - 10	24	2 4 7 9	11	20	634.5					2.25			12	
SS - 11	24	3 5 7 8	12				CL			1.5-2.0			15	
SS - 12	24	3 4 6 7	10							1.0			16	
SS - 13	24	2 3 6 7	9	25	629.5	26 (628.5)				1.0			15	
						End of Boring at 26.0 ft.								
				30	624.5									

WATER & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: NE	CAVE DEPTH AT COMPLETION: N/A	WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: NE	CAVE DEPTH AFTER 0 HOURS: N/A	WET ☐ DRY ☐
▼	WATER LEVEL AFTER 0 HOURS: NE	NE = Not Encountered; NMR = No Measurement Recorded	

NOTE: Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: NW GARAGE CNG STATION	Local Grid Location of Well: _____ ft. ☐ N. ☐ S. _____ ft. ☐ E. ☐ W.	Well Name: MW-1
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No. / DNR Well ID No.
Facility ID	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed: 03/07/2013 (m m d d y y y y)
Type of Well: Well Code ____/____	Section Location of Waste/Source: ____ 1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W	Well Installed By: Name (first, last) and Firm: GESTRA ENGINEERING
Distance from Waste/Source _____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number

A. Protective pipe, top elevation ____.0 ft. MSL

B. Well casing, top elevation ____-1 ft. MSL

C. Land surface elevation ____0 ft. MSL

D. Surface seal, bottom ____ ft. MSL or 13 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐ ____

15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe _____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top ____ ft. MSL or 1 ft.

F. Fine sand, top ____ ft. MSL or ____ ft.

G. Filter pack, top ____ ft. MSL or 13 ft.

H. Screen joint, top ____ ft. MSL or 15 ft.

I. Well bottom ____ ft. MSL or 25 ft.

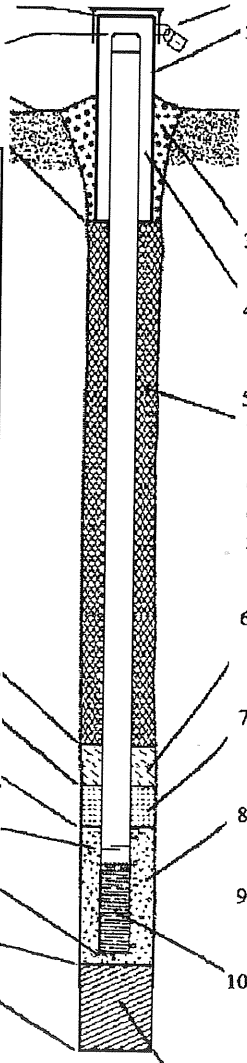
J. Filter pack, bottom ____ ft. MSL or 25 ft.

K. Borehole, bottom ____ ft. MSL or 25 ft.

L. Borehole, diameter 7 in.

M. O.D. well casing 2 in.

N. I.D. well casing 2 in.



1. Cap and lock? ☐ Yes ☒ No

2. Protective cover pipe:
a. Inside diameter: 8 in.
b. Length: 1 ft.
c. Material: Steel ☒ 04 / Other ☐ ____
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____

3. Surface seal: Bentonite ☐ 30 / Concrete ☒ 01 / Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☒ 30 / Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 32
c. _____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. _____
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. #5 SAND
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐ ____

10. Screen material: SCH 40 PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐ ____
b. Manufacturer _____
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.

11. Backfill material (below filter pack): None ☒ 14 / Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
[signature]	GESTRA ENGINEERING

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐ Remediation/Redevelopment ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: NW GARAGE CNG STATION	Local Grid Location of Well: _____ ft. ☐N. ☐S. _____ ft. ☐E. ☐W.	Well Name: MW-2
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No. / DNR Well ID No.
Facility ID	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed: 03/07/2013 (m m d d y y y y)
Type of Well: Well Code ____/____	Section Location of Waste/Source: ____1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐E ☐W	Well Installed By: Name (first, last) and Firm: GESTRA ENGINEERING
Distance from Waste/Source _____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number: _____

A. Protective pipe, top elevation ____0____ ft. MSL

B. Well casing, top elevation ____-1____ ft. MSL

C. Land surface elevation ____0____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or ____9.5____ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☒ 41; Other ☐ _____

15. Drilling fluid used: Water ☐ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe _____

17. Source of water (attach analysis, if required):

_____

E. Bentonite seal, top _____ ft. MSL or ____1____ ft.

F. Fine sand, top _____ ft. MSL or ____—____ ft.

G. Filter pack, top _____ ft. MSL or ____9.5____ ft.

H. Screen joint, top _____ ft. MSL or ____11.5____ ft.

I. Well bottom _____ ft. MSL or ____21.5____ ft.

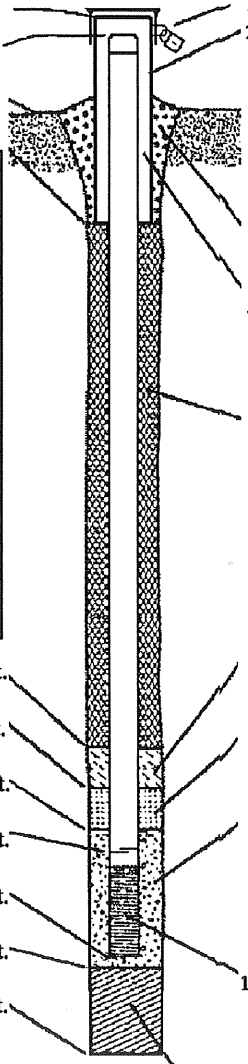
J. Filter pack, bottom _____ ft. MSL or ____21.5____ ft.

K. Borehole, bottom _____ ft. MSL or ____21.5____ ft.

L. Borehole, diameter ____7____ in.

M. O.D. well casing ____2____ in.

N. I.D. well casing ____2____ in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: ____8____ in.
b. Length: ____1____ ft.
c. Material: Steel ☒ 04; Other ☐ _____
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____

3. Surface seal: Bentonite ☐ 30; Concrete ☒ 01; Other ☐ _____

4. Material between well casing and protective pipe: Bentonite ☒ 30; Other ☐ _____

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☒3/8 in. ☐1/2 in. Bentonite chips ☒ 32
c. _____ Other ☐ _____

7. Fine sand material: Manufacturer, product name & mesh size
a. _____
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. #5 SAND
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23; Flush threaded PVC schedule 80 ☐ 24; Other ☐ _____

10. Screen material: SCH 40 PVC
a. Screen type: Factory cut ☒ 11; Continuous slot ☐ 01; Other ☐ _____
b. Manufacturer _____
c. Slot size: 0.010 in.
d. Slotted length: ____10____ ft.

11. Backfill material (below filter pack): None ☒ 14; Other ☐ _____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
	GESTRA ENGINEERING

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: NW GARAGE CNG STATION	Local Grid Location of Well: _____ ft. ☐ N. ☐ S. _____ ft. ☐ E. ☐ W.	Well Name: MW-3
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No. / DNR Well ID No.
Facility ID	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed: 03/08/2013 (m m d d y y y y)
Type of Well: Well Code ____/____	Section Location of Waste/Source: ____1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐ E ☐ W	Well Installed By: Name (first, last) and Firm: GESTRA ENGINEERING
Distance from Waste/Source _____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known / Gov. Lot Number	

A. Protective pipe, top elevation ____3____ ft. MSL

B. Well casing, top elevation ____3____ ft. MSL

C. Land surface elevation ____0____ ft. MSL

D. Surface seal, bottom ____ ft. MSL or ____13____ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐ ____

15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe _____

17. Source of water (attach analysis, if required):

_____

E. Bentonite seal, top ____ ft. MSL or ____0____ ft.

F. Fine sand, top ____ ft. MSL or ____ ft.

G. Filter pack, top ____ ft. MSL or ____13____ ft.

H. Screen joint, top ____ ft. MSL or ____15____ ft.

I. Well bottom ____ ft. MSL or ____25____ ft.

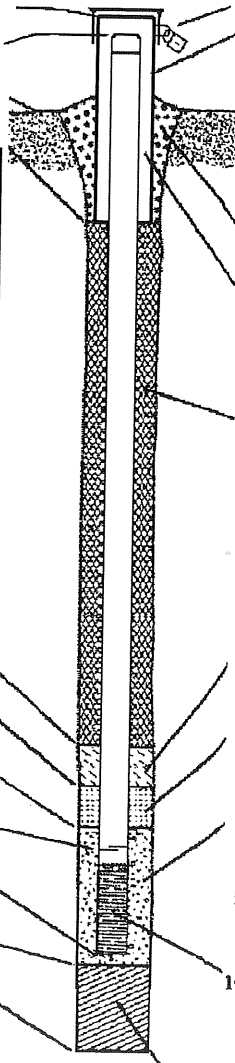
J. Filter pack, bottom ____ ft. MSL or ____25____ ft.

K. Borehole, bottom ____ ft. MSL or ____25____ ft.

L. Borehole, diameter ____7____ in.

M. O.D. well casing ____2____ in.

N. I.D. well casing ____2____ in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: ____4____ in.
b. Length: ____5____ ft.
c. Material: Steel ☒ 04 / Other ☐ ____
d. Additional protection? ☐ Yes ☒ No
If yes, describe: _____

3. Surface seal: Bentonite ☒ 30 / Concrete ☐ 01 / Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☒ 30 / Other ☐ ____

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 32
c. _____ Other ☐ ____

7. Fine sand material: Manufacturer, product name & mesh size
a. _____
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. #5 SAND
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐ ____

10. Screen material: SCH 40 PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐ ____
b. Manufacturer _____
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.

11. Backfill material (below filter pack): None ☒ 14 / Other ☐ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
	GESTRA ENGINEERING

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

GENERAL NOTES

DRILLING AND SAMPLING SYMBOLS

SYMBOL	DEFINITION
HSA	Hollow Stem Auger
RWB	Rotary Wash Boring (Mud Drilling)
_FA	4", 6" or 10" Diameter Flight Auger
_HA	2", 4" or 6" Hand Auger
_DC	2 1/2" , 4" , 5" or 6" Steel Drive Casing
_RC	Size A, B, or N Rotary Casing
PD	Pipe Drill or Cleanout Tube
CS	Continuous Split Spoon Sampling
DM	Drill Mud
JW	Jetting Water
SS	2" O.D. Split Spoon Sample
_L	2 1/2" or 3 1/2" O.D. SB Liner Sample
ST	3" Thin Walled Tube Sample (Shelby Tube)
3TP	3" Thin Walled Tube (Pitcher Sampler)
_TO	2" or 3" Thin Walled Tube (Osterberg Sampler)
W	Wash Sample
B	Bag Sample
P	Test Pit Sample
_Q	BQ, NQ, or PQ Wireline System
_X	AX, BX, or NX Double Tube Barrel
CR	Core Recovery – Percent
NSR	No Sample Recovered, classification based on action of drilling, equipment and/or material noted in drilling fluid or on sampling bit.
NMR	No Measurement Recorded, primarily due to presence of drilling or coring fluid.
▽	Water Level Symbol

TEST SYMBOLS

SYMBOL	DEFINITION
MC	Moisture Content - % of Dry Wt. – ASTM D 2216
OC	Organic Content - % of Dry Wt. – ASTM D 2974
DD	Dry Density – Pounds Per Cubic Foot
LL, PL	Liquid and Plastic Limit – ASTM D 4318
	Additional Insertions
Qu	Unconfined Comp. Strength-psf – ASTM D 2166
Qp	Penetrometer Reading – Tons/Square Foot
Ts	Torvane Reading – Tons/Square Foot
G	Specific Gravity – ASTM D 854
SL	Shrinkage Limits – ASTM D 427
OC	Organic Content – Combustion Method
SP	Swell Pressure - Tons/Square Foot
PS	Percent Swell
FS	Free Swell – Percent
pH	Hydrogen Ion Content. Meter Method
SC	Sulfate Content – Parts/ Million, same as mg/L
CC	Chloride Content - Parts/ Million, same as mg/L
C*	One Dimensional Consolidation – ASTM D 2453
Qc*	Triaxial Compression
D.S.*	Direct Shear – ASTM D 3080
K*	Coefficient of Permeability – cm/sec
D*	Dispersion test
DH*	Double Hydrometer – ASTM D 4221
MA*	Particle Size Analysis – ASTM D 422
R	Laboratory Receptivity, in ohm – cm – ASTM G 57
E*	Pressuremeter Deformation Modulus – TSF
PM*	Pressuremeter Test
VS*	Field Vane Shear – ASTM D 2573
IR*	Infiltrometer Test – ASTM D 3385
RQD	Rock Quality Designation – Percent

*See attached data sheet or graph

WATER LEVEL

Water levels shown on the boring logs are the levels measured in the borings at the time and under the conditions indicated. In sand, the indicated levels may be considered reliable ground water levels. In clay soil, it may not be possible to determine the ground water level within the normal time required for test borings, except where lenses or layers of more pervious waterbearing soil are present. Even then, an extended period of time may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed texture soils may not indicate the true level of the ground water table. Perched water refers to water above an impervious layer, thus impeded in reaching the water table. The available water level information is given at the bottom of the log sheet.

DESCRIPTIVE TERMINOLOGY

DENSITY TERM	"N" VALUE
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

CONSISTENCY TERM	Unconfined Compressive Strength, (tsf)	"N" VALUE
Very Soft	<0.25	0-2
Soft	0.25 - 0.49	2-4
Medium Stiff	0.5 - 0.99	4-8
Stiff	1.0 - 1.99	8-16
Very Stiff	2.0 - 3.99	16-30
Hard	4.0+	Over 30

Standard "N" Penetration: Blows per Foot of a 140 Pound Hammer Falling 30 inches on a 2 inch OD Split Barrel Sampler

Lamination	Up to 1/2" thick stratum
Layer	1/2" to 6" thick stratum
Lens	1/2" to 6" discontinuous stratum
Varved	Alternating laminations
Dry	Powdery, no noticeable water
Moist	Below saturation
Wet	Saturated, above liquid limit
Water bearing	Pervious soil below water

RELATIVE GRAVEL PROPORTIONS

CONDITION	TERM	RANGE
Coarse Grained Soils	trace of gravel	2-14%
	with gravel	15-49%
Fine Grained Soils		
15-29% + No. 200	trace of gravel	2-14%
15-29% + No. 200	with gravel	15-29%
30% + No. 200	trace of gravel	2-14%
30% + No. 200	with gravel	15-24%
30% + No. 200	gravelly	25-49%

RELATIVE SIZES

Boulder	Over 12"
Cobble	3" - 12"
Gravel	
Coarse	3/4" - 3"
Fine	#4 – 3/4"
Sand	
Coarse	#4 - #10
Medium	#10 - #40
Fine	#40- #200
Silt & Clay	- # 200, Based on Plasticity

SOILS CLASSIFICATION FOR ENGINEERING PURPOSES

ASTM Designation: D 2487 - 83

(Based on Unified Soil Classification System)

SOIL ENGINEERING

		Criteria for Assigning GroupSymbols and Group Names Using Laboratory Tests [A]		Soil Classification[B] Group Symble	Group Name
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less Than 5% fines [C]	Cu≥ 4 and 1≤ Cc ≤3[E]	GW	Well graded gravel [F]
			Cu< 4 and/or 1> Cc >3[E]	GP	Poorly graded gravel [F]
		Gravels with Fines more than 12% fines [C]	Fines Classify as ML or MH	GM	Silty gravel [F.G.H.]
			Fines classify as CL or CH	GC	Clayey gravel [F.G.H.]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean sandss Less than 5% fines [D]	Cu≥ 6 and 1≤ Cc ≤3[E]	SW	Well graded sand [I]
			Cu< 6 and/or 1> Cc >3[E]	SP	Poorly graded sand [I]
		Sands with Fines more than 12% fines [D]	Fines Classify as ML or MH	SM	Silty sand [G.H.I]
			Fines classify as CL or CH	SC	Clayey sand [G.H.I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid Limit less than 50	inorganic	PI >7 and plots on or above " A" line	CL	Lean clay [K.L.M]
			PI<4 or plots below " A " line	ML	Silt [K.L.M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K.L.M.N] Organic Silt [K.L.M.O]
	Silts and Clays Liquid Limit 50 or more	inorganic	PI plots on or above " A " line	CH	Fat clay [K.L.M]
			PI plots below " A " line	MH	Elastic silt [K.L.M]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K.L.M.P] Organic Silt [K.L.M.Q]
Highly organic Soils		Primarily organic matter, dark in color, and organic odor		PT	Peat
Fibric Peat > 67% Fibers		Hemic Peat 33 % - 67 % Fibers		sapric	Peat < 33% Fibers

[A] Based on the material passing the 3-in (75- mm)sieve

[B] If field sample contained cobbles or boulders, or both. add with cobbles or boulders, or both to group name

[C] Gravels with 5 to 12 % fines require dual symbols:
GW - GM well-graded gravel with silt
GW - GC well-graded gravel with clay
GP - GM poorly-graded gravel with Silt
GP - GC poorly-graded gravel with clay

[D] Sands with 5 to 12 % fines require dual symbols:
SW -SM well-graded sand with silt
SW - SC well-graded sand with clay
SP - SM poorly-graded sand with Silt
SP - SC poorly-graded sand with clay

[E] $Cu = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name

[G] If fines classify as CL-ML, use dual symbol GC-GM. or SC-SM

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL_ML silty clay
If soil contains 15 to 29% plus No. 200, add, "with sand" or " with gravel", whichever is predominent

[L] If soil contains ≥ 30% plus No.200, predominantly sand, add "sandy" to the group name

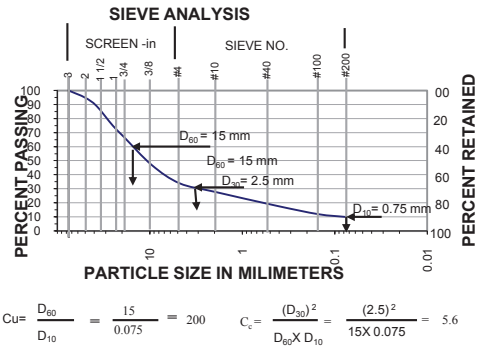
[M] If soil contains ≥ 30% plus No.200, predominantly gravel add "gravelly" to the group name

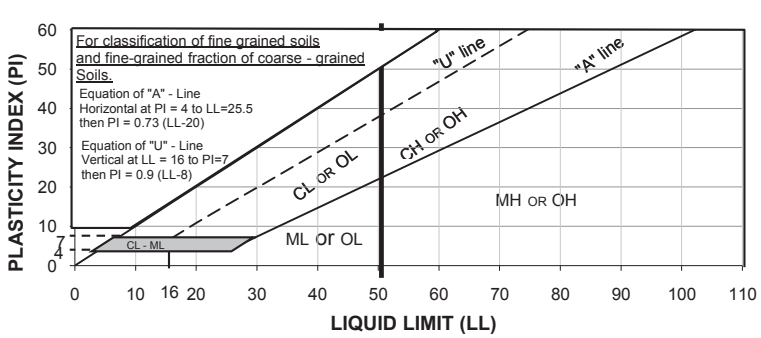
[N] PI ≥4 and plots on or above "A" Line

[O] PI < 4 or plots below "A" Line

[P] PI plots on or above "A" Line

[Q] PI plots below "A" Line





Geotechnical -Structural- Pavement - Construction Materials

APPENDIX II

LABORATORY TEST RESULTS

Wisconsin Department of Commerce
Division of Safety and Buildings

SOIL EVALUATION - STORM

in accordance with Comm 82.365 & 85, Wis. Adm. Code

Attach complete site plan on paper not less than 8 1/2 x 11 inches in size. Plan must include, but not limited to: vertical and horizontal reference point (BM), direction and percent slope, scale or dimensions, north arrow, and BM referenced to nearest road.

Please print all information.

Personal information you provide may be used for secondary purposes (Privacy Law, s. 15.04 (1) (m)).

County: Milwaukee
Parcel I.D.: 2309992100
Reviewed by: Date:

Property Owner	Property Location
City of Milwaukee, D.P.W	Govt. Lot 1/4 1/4 S T N R E (or) W
Property Owner's Mailing Address: 809 N. Broadway 2nd Floor	Lot # / Block # / Subd. Name or CSM#
City / State / Zip Code / Phone Number: Milwaukee / WI / 53202 / ( )	☒ City ☐ Village ☐ Town / Nearest Road: Milwaukee

Drainage area _____ ☐ sq. ft. ☐ acres
Optional:
Test Site Suitable for (check all that apply)
☐ Irrigation ☐ Bioretention trench ☐ Trench(es)
☐ Rain garden ☐ Grassed swale ☐ Reuse
☐ Infiltration trench ☐ SDS (> 15' wide) ☐ Other _____

Hydraulic Application Test Method:
☐ Morphological Evaluation
☐ Double-Ring Infiltrometer
☐ Other (specify) _____

B-2 Obs. # ☒ Boring ☐ Pit Ground surface elev. 656.7 ft. Depth to limiting factor _____ in.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frag.	Hydraulic App. Rate Inches/Hr
A(FILL)	0-7	10YR 2/1		SiC				—	
FILL	7-66	7.5YR 5/6		CL				20	
B	66-156	7.5YR 5/4		C				0	
B	156-168	7.5YR 3/1		SiL				10	
B	168-240	2.5Y 5/3		SiCL				5	

B-3 Obs. # ☒ Boring ☐ Pit Ground surface elev. 654.5 ft. Depth to limiting factor _____ in.

Horizon	Depth in.	Dominant Color Munsell	Redox Description Qu. Sz. Cont. Color	Texture	Structure Gr. Sz. Sh.	Consistence	Boundary	% Rock Frag.	Hydrualic App. Rate Inches/Hr
A(FILL)	0-8	10YR 2/1		SiC				—	
FILL	8-15	10YR 3/1		L				15	
FILL	15-48	7.5YR 4/3		C				0	
FILL	48-72	7.5YR 4/6		C				0	
B	72-192	7.5YR 4/5		C				0-5	
B	192-312	10YR 4/2		C				5-10	

CST/PSS Name (Please Print): Jeff Bruesewitz
Signature:
CST/PSS Number:
Address: 1626 W. Fond du Lac Ave, Milwaukee, WI 53205
Date Evaluation Conducted: 3/18/13
Telephone Number: (414)933-7444

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name: NW Garage CNG Fueling Station
Project Number: 13012-10
Project Location: Milwaukee, WI
ASTM Designation: **D2216, D 2974**

Date: March 11, 2013
Report To: The Sigma Group

Boring Number	B-1	B-1	B-1	B-1	B-1	B-1		
Sample Number	1	2	3	4	5	6		
Cup Number	B20	G4	G7	B27	321	11		
Weight of Cup (g)	14.33	14.74	14.82	14.37	16.85	15.61		
Weight of Wet Soil and Cup (g)	54.20	67.34	77.44	47.80	56.48	61.20		
Weight of Dry Soil and Cup (g)	48.39	58.15	65.15	39.94	47.24	53.68		
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	17.1	21.2	24.4	30.7	30.4	19.8		
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number								
Sample Number								
Cup Number								
Weight of Cup (g)								
Weight of Wet Soil and Cup (g)								
Weight of Dry Soil and Cup (g)								
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)								
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by JB

Reviewed by R. English

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name: NW Garage CNG Fueling Station
Project Number: 13012-10
Project Location: Milwaukee, WI
ASTM Designation: **D2216, D 2974**

Date: March 11, 2013
Report To: The Sigma Group

Boring Number	B-2	B-2	B-2	B-2	B-2	B-2	B-2	B-2
Sample Number	1 (topsoil)	1 (lean clay)	2	3	4	5	6	7
Cup Number	PC-101	M2	S14	20	35	S18	S23	J28
Weight of Cup (g)	69.26	13.51	13.99	15.37	16.98	15.96	16.47	13.00
Weight of Wet Soil and Cup (g)	112.47	41.10	73.07	55.40	49.78	53.69	47.39	60.88
Weight of Dry Soil and Cup (g)	99.82	36.41	66.03	48.17	43.73	46.75	41.24	54.13
Weight of Soil and Cup After Burn (g)	96.62							
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	41.4	20.5	13.5	22.0	22.6	22.5	24.8	16.4
Organic Content (%)	10.5							
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number	B-2	B-2	B-2					
Sample Number	8	9	10					
Cup Number	J8	S8	G1					
Weight of Cup (g)	13.18	16.22	13.75					
Weight of Wet Soil and Cup (g)	57.52	54.39	48.87					
Weight of Dry Soil and Cup (g)	51.82	50.37	44.23					
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	14.8	11.8	15.2					
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by JB

Reviewed by R. English

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of
Moisture Content, Organic Content, and Density of Soil

Project Name: NW Garage CNG Fueling Station
Project Number: 13012-10
Project Location: Milwaukee, WI
ASTM Designation: **D2216, D 2974**

Date: March 11, 2013
Report To: The Sigma Group

Boring Number	B-3	B-3	B-3	B-3	B-3	B-3	B-3	B-3
Sample Number	1	2	3	4	5	6	7	9
Cup Number	B9	G2	B15	B2	B11	J2	A26	12
Weight of Cup (g)	14.35	14.46	14.26	14.41	14.50	13.38	15.63	15.66
Weight of Wet Soil and Cup (g)	24.98	48.33	50.82	56.10	51.41	46.48	55.55	54.93
Weight of Dry Soil and Cup (g)	22.70	40.71	43.36	48.90	44.42	39.99	48.33	50.23
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	27.3	29.0	25.6	20.9	23.4	24.4	22.1	13.6
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Boring Number	B-3	B-3	B-3	B-3				
Sample Number	10	11	12	13				
Cup Number	3	J18	X22	13				
Weight of Cup (g)	16.22	14.03	13.72	15.48				
Weight of Wet Soil and Cup (g)	57.56	56.79	55.45	47.01				
Weight of Dry Soil and Cup (g)	53.22	51.15	49.76	42.85				
Weight of Soil and Cup After Burn (g)								
Weight of Sample for Density (lbs)								
Diameter (in)								
Length(in)								
Moisture Content (%)	11.7	15.2	15.8	15.2				
Organic Content (%)								
Wet Density (pcf)								
Dry Density (pcf)								

Performed by JB

Reviewed by R. English

GESTRA Engineering, Inc
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Milwaukee, WI 53205
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Laboratory Test Results of Atterberg Limits of Soil

Project Name:	NW Garage CNG Fueling Station	Date:	March 15, 2013
Project Number:	13012-10	Client:	The Sigma Group
Project Location:	Milwaukee, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	B-2
Sample Number	SS-2, & SS-3
Depth of Sample	2'-6'

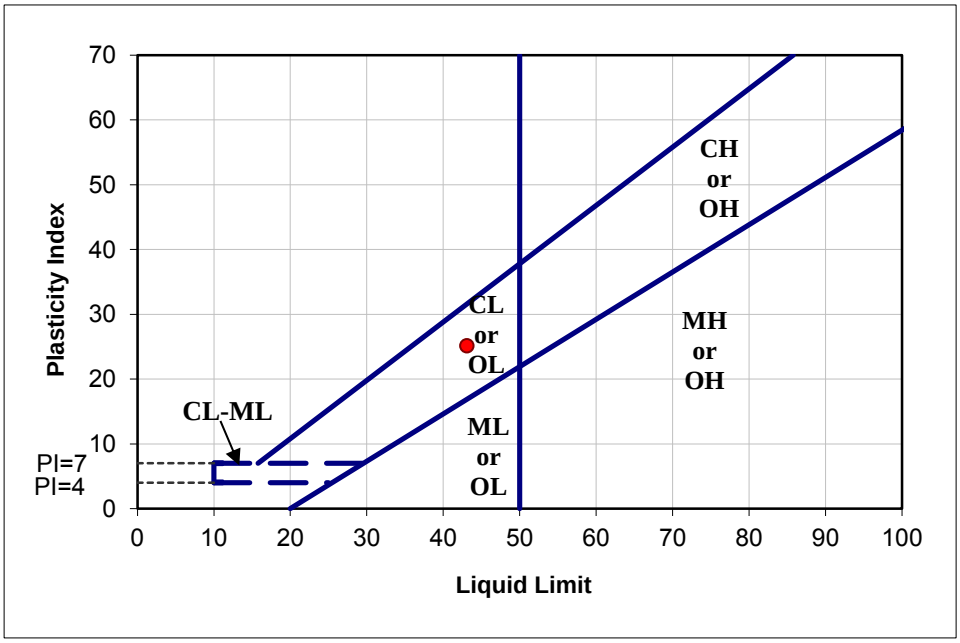
Determination of Liquid Limit

Cup Number	J28	S18	X22
Weight of Cup (g)	12.98	15.94	13.71
Weight of Wet Soil and Cup (g)	33.65	34.86	35.93
Weight of Dry Soil and Cup (g)	27.57	29.14	29.07
Moisture Content (%)	41.7	43.3	44.7
Blow Counts	34	22	17

Determination of Plastic Limit

Cup Number	9B	G2
Weight of Cup (g)	6.59	6.22
Weight of Wet Soil and Cup (g)	14.38	12.29
Weight of Dry Soil and Cup (g)	13.17	11.35
Moisture Content (%)	18.4	18.3

Compilation of Test Results



Liquid Limit	43
Plastic Limit	18
Plasticity Index	25
USCS Symbol	**CL**

Performed by: JB

Reviewed By: R. English

GESTRA Engineering, Inc.

GESTRA Engineering, Inc
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Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results of Atterberg Limits of Soil

Project Name:	NW Garage CNG Fueling Station	Date:	March 15, 2013
Project Number:	13012-10	Client:	The Sigma Group
Project Location:	Milwaukee, WI		
ASTM Designation:	**D4318**		

Sample Information

Type of Sample	Split Spoon
Boring Number	B-3
Sample Number	5
Depth of Sample	8'-10'

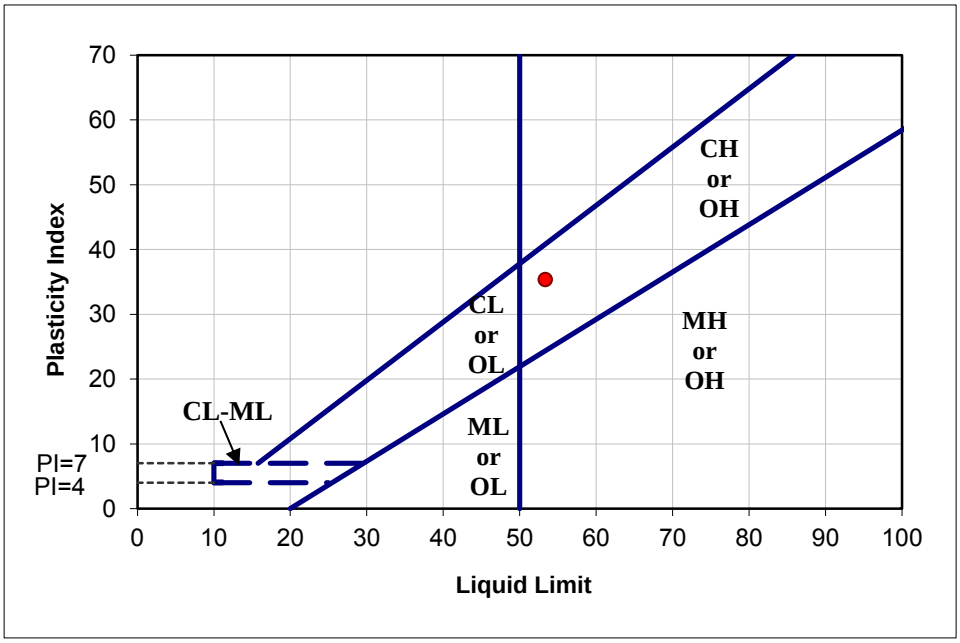
Determination of Liquid Limit

Cup Number	S8	12	M2
Weight of Cup (g)	16.23	15.65	13.48
Weight of Wet Soil and Cup (g)	37.45	39.87	35.70
Weight of Dry Soil and Cup (g)	30.16	31.45	27.87
Moisture Content (%)	52.3	53.3	54.4
Blow Counts	31	25	19

Determination of Plastic Limit

Cup Number	19A	9D
Weight of Cup (g)	6.35	6.28
Weight of Wet Soil and Cup (g)	12.43	12.46
Weight of Dry Soil and Cup (g)	11.49	11.49
Moisture Content (%)	18.3	18.6

Compilation of Test Results



Liquid Limit	53
Plastic Limit	18
Plasticity Index	35
USCS Symbol	**CH**

Performed by: JB

Reviewed By: R. English

GESTRA Engineering, Inc.

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Laboratory Test Results of
Amount of Soil finer than #200 Sieve

Project Name:	NW Garage CNG Fueling Station	Date:	March 14, 2013
Project Number:	12013-10	Report To:	The Sigma Group
Project Location:	Milwaukee Co., WI		
ASTM Designation:	**D1140**		

Boring Number	B-3							
Sample Number	4							
Weight of Pan (g)	119.2							
Weight of Wet Soil and Pan (g)	317.5							
Weight of Wet Soil (g)	198.3							
Weight of Dry Soil and Pan (g)	281.9							
Weight of Dry Soil (g)	162.7							
Weight of Soil and Pan after Wash (g)	119.7							
Weight of Soil after Wash (g)	0.5							
Precentage of Material Passing #200 (%)	99.7							
Moisture Content (%)	21.88							

Boring Number								
Sample Number								
Weight of Pan (g)								
Weight of Wet Soil and Pan (g)								
Weight of Wet Soil (g)								
Weight of Dry Soil and Pan (g)								
Weight of Dry Soil (g)								
Weight of Soil and Pan after Wash (g)								
Weight of Soil after Wash (g)								
Precentage of Material Passing #200 (%)								
Moisture Content (%)								

Performed by JB Reviewed by R. English

GESTRA Engineering, Inc
1626 W. Fond Du Lac Ave.
Milwaukee, WI 53205
Phone: (414) 933-7444, Fax: (414) 933-7844

Laboratory Test Results of Unconfined Compressive Strength of Soil

Project Name: NW Garage CNG Fueling Station
Project Number: 13012-10
Project Location: Milwaukee, WI
ASTM Designation: **D2166**

Date: March 14, 2013
Report To: The Sigma Group

Updated on September 20, 2012

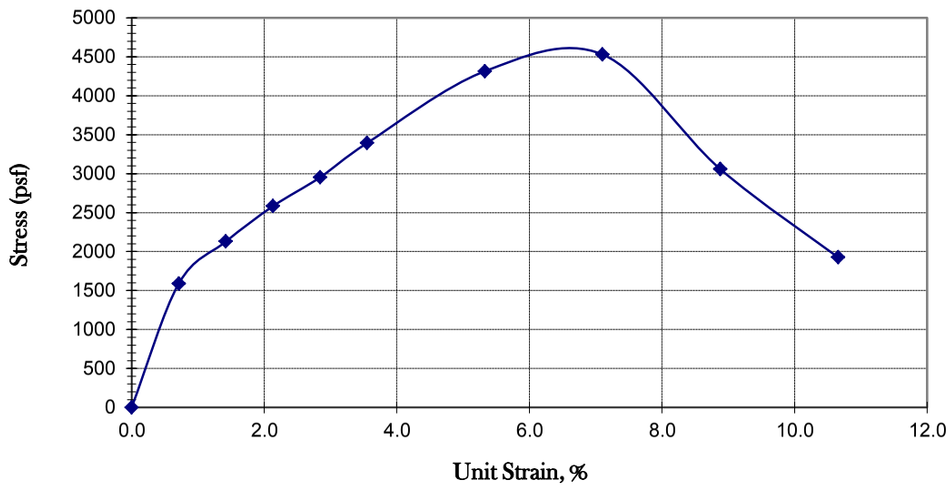
Test Data

Deformation dial reading (0.001 in.)	Sample stress (psf)
0	0
20	1587
40	2128
60	2582
80	2951
100	3392
150	4314
200	4530
250	3059
300	1928

Sample Information

Boring no.: B-1
Sample no.: 3
Depth of Soil: 6'-7.5'
Description of Soil: CL/CH, light brown, moist
Strain Rate (in/min): 0.042

Diameter (in) 1.39
Area (sq. in.): 1.53
Height: (in.): 2.82



UC Strength, Q_u (tsf)	**2.26**
Wet Density (pcf)	126.1
Dry Density (pcf)	101.4
Moisture Content (%)	24.4

Remarks
Sample displayed inclined shear fracture at failure.

Performed By: JB

Reviewed By: R. English
GESTRA Engineering, Inc.

GESTRA Engineering, Inc
1626 W. Fond du Lac Avenue
Milwaukee, WI 53205
Phone: (414) 933-7444; Fax: (414) 933-7844

Laboratory Test Results

Project Name:	NW Garage CNG Fueling Station	Date:	March 20, 2013
Project Number:	13012-10	Report To:	The SIGMA Group
Project Location:	Milwaukee, WI		

Laboratory Test Results of Resistivity of Soil (McMiller Box)

ASTM Designation: G57

Boring Number	B-2	
Sample Number	SS-4	
Moisture Content (%)	22.6	
Temperature of Sample (°F)	70.70	
Temperature of Sample (°C)	21.50	
Resistivty Value (Ω*cm)	1600	
Corrected Resistivty Value (Ω*cm)	1840	

Laboratory Test Results of pH of Soils

ASTM Designation: D4972-Method A "pH meter"

Boring Number		
Sample Number		
pH with Water Solution		
pH with Calcium Chloride Solution		

Performed by: ESJ

Reviewed By: RHE

GESTRA Engineering

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. In general, the project includes the installation of a CNG fueling station and the construction of CNG vehicle maintenance bays.

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

C. The following outline is intended to serve as a general guide only, and not as a complete listing of work, operations, or materials. Consult the Table of Contents for a complete listing of items included.

1. The expansion of the CNG system will consist of the addition of a public accessed, fee-for-service fast-fill re-fueling area.
2. Conversion of a portion of an existing high bay vehicle storage facility into a CNG vehicle maintenance facility: The proposed maintenance bays for CNG truck service are required to be separated from the vehicle storage and other maintenance activity areas. New concrete masonry walls, extending to the roof deck above, will be constructed on new foundations to create this separation. Access to the maintenance bays is from the existing internal garage circulation. New coiling overhead doors in the new walls will separate the maintenance facility from the storage garage. New mechanical, electrical and plumbing systems serving only the proposed CNG maintenance area will be provided.

D. Examine Documents and Visit Site:

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

None.

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 the City 48 hours in advance before starting work.

D. 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.

E. Shut downs of any equipment and connections to any equipment must be arranged in advance with the Project Inspector from Facilities Development and Management. Power outages must be scheduled for Saturdays.

F. Dispose of all removed materials in legal manner.

G. The contractor shall provide a construction schedule which includes all phases of construction. The contractor shall provide that complete schedule at the Pre-Construction Meeting arranged by the City.

H. Project Total working days does 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 Manager of Buildings & Fleet Services. Such review shall apply to design only and shall in no way relieve the contractor from the responsibilities as outlined in Item 2B above. Evaluation of "or equal" products will be made at the time of shop drawing submission. Any change required in design and coordination between all contractors, subcontractors, or trades due to the use of "or equal" materials shall become the contractor's responsibility. Any costs for detailed engineering reviews and/or any costs to incorporate "or equal" products will be borne by the contractor.

3. PERMITS:

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

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

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

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

4. INSPECTION:

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

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

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

SECTION 01500: JOB SITE UTILITIES, FACILITIES, AND SECURITY

1. SCOPE:

A. Index:

1. Scope
2. Building Security
3 Temporary or Trial Usage
4. Occupancy During Construction
5. Scaffolding
6. Electrical Power
7. Water
8. Toilet Facilities
9. Security and Weather Protection
10. Parking

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. City Agents

Any City agent who commissions outside contractors to work in any of the facilities managed by DPW-Facilities Development and Management 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.

D. 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-Facilities Development and Management 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.
4. Section 01735 “Selective Demolition” for disposition of waste resulting from partial demolition of buildings, structures, and site improvements and for disposition of hazardous waste.

1.3 PRECONSTRUCTION MEETING:

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

1.4 CONSTRUCTION WASTE MANAGEMENT PLAN:

A. Construction Waste Management Plan
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 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:

E. 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.

F. 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.

G. 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 Buildings & Fleet Services Project Inspector.

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

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

E. Store with seals and labels intact and legible.

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

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

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

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

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

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

6. PROTECTION:

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

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

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

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

7. REVISIONS:

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

SECTION 01700: CLEANING AND PROJECT CLOSE-OUT

1. SCOPE:

A. Index:

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

2. GENERAL:

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

3. SAFETY CLEANING:

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

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

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

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

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

a. Identity of the hazardous chemical(s).

b. Appropriate hazard warning(s).

4. PROGRESS CLEANING:

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

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

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

5. DISPOSAL:

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

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

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

6. FINAL CLEANING:

   A. Immediately prior to substantial completion.

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

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

7. CHARGES:

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

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

8. RECORD DRAWINGS:

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

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

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

9. OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS:

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

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

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

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

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

10. GUARANTEES:

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

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

SECTION 01740 - WARRANTY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and other Division 1 Specification sections, apply to work of this section.

B. Related Sections

1. Section 01300 - Submittals

1.02 WARRANTY

A. The specified roof sections will receive the following a twenty year (20) no dollar limit (NDL) Edge-to-Edge Roof System labor and material warranty, including all metal panels, metal coping, and sheet metal accessories, by one manufacturer. Multiple warranties are not acceptable.

B. The material manufacturer will provide two inspections per year (at no additional cost) for the duration of the warranty.

C. The warranty shall cover all roof related components installed under this specification and shall not be limited to only those materials supplied by the material supplier issuing the warranty.

D. Specifically - The warranty submitted by the manufacturer of record will cover:

1. All labor.

2. Materials by the manufacturer of record.

3. Materials by others (as approved by manufacturer).

E. The contractor shall issue to the material supplier a two (2) year labor warranty upon completion of the roof and acceptance by the material supplier’s representative and the City.

1.03 MAINTENANCE REQUIREMENTS (by owner)

A. Clean all drains, gutters and down spouts.

B. Check for physical abuse by other trades.

C. Inspect and confirm weather damage.

1.04 THE MANUFACTURER OF RECORD

A. Will not charge for any warranty problem inspections nor will any charges be assessed by the contractor of record.

B. Provide an annual inspection of the roof system at the request of the building owner.

END OF SECTION

SECTION 013100
PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Coordination of Work of Contract from beginning of construction activity through Project close-out and warranty periods.
   2. Patient confidentiality requirements for healthcare facilities work.

B. Related Sections:
   1. Section 00700 - General Conditions.
   2. Section 01010 - Summary of Work.
   3. Section 01700 – Cleaning and Project Closeout.
   4. Section 015210 - Construction Facilities.
   5. Section 015110 - Temporary Utilities.
   6. Section 017329 – Cutting and Patching.
   7. Section 013216 – Construction Progress Schedules.
   8. Section 024119 – Selective Demolition.

1.2 SUBMITTALS

A. Coordination Drawings: Submit in accordance with Section 013300, and as specified herein.

1.3 COORDINATION SCHEDULING

A. Schedule Coordination: Special coordination and cooperation efforts are required for certain interrelated phases of the work, such as:
   1. Sequencing of remodeling work.
   2. Construction of temporary spaces and facilities;
   3. Removals and relocations of existing services and facilities;
   4. Ceiling work; connecting the Owner's equipment;
   5. Installation of and connections to new utilities;
   6. Connections to existing buildings;
   7. Demolition work;
   8. Providing and maintaining temporary heat and other temporary facilities; and similar work.

B. Coordinate scheduling, work activities, submittals, including deferred approvals (if any), Owner's separate contracts (if any), Owner’s material/product direct purchase (if any), and work of the various sections of Specifications to assure efficient and orderly sequence of installation of construction elements, with provisions for accommodating items to be installed later.

C. Coordinate sequence of Work to accommodate any Owner's separate contracts and Owner Occupancy as specified in Section 01010.

D. General: The nature of the Project makes it imperative that the Contractor and all subcontractors coordinate their work and cooperate with each other and the Owner from the start of the Project to completion.
   1. The General Contractor is the Prime Coordinator for the Project and shall establish the overall schedule for the progress of the Project, the sequence of completion and general use of the site.

E. Notice: Give adequate and timely notice of various work phases and operations which will affect the work of, or will require installations or other action by others.
   1. After timely notification by the Contractor of the need to accomplish a particular phase or element of the Work, the Subcontractors shall, within a reasonable time, perform their work as not to delay or impede others or the progress of the Project.

F. Set up control procedures so that approved schedules are adhered to. Contractor's responsibility is to properly notify Owner's Representative of anticipated and actual time delays.
   1. Refer to General Conditions.

G. Contractor's job superintendent shall be on the job continuously.
   1. Refer to General Conditions.

H. Coordinate the Work and do not delegate responsibility for coordination to any Subcontractor.

I. Anticipate the interrelationship of all Subcontractors, Owner's separate contracts, and their relationship with the Work.

J. Resolve differences or disputes between Subcontractors concerning coordination, interference, or extent of Work between Sections.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Not used.

PART 3 EXECUTION

3.1 SHUT DOWN PROCEDURES

A. A shutdown is any interruption of services provided by the Owner to its clients and staff. Ensure that an inspector has been assigned to coordinate shutdown in the field. Assist the inspector in preparing a shutdown script.

B. Verify with the Contractor and assigned Safety Director that all appropriate Owner Interim Life Safety Measures (ILSMS) (if any) are in place.

C. Determine if all proper and appropriate coordination and notification has been completed, before the shutdown.

D. Shutdown Request: Attached to the end of this section is a copy of the shutdown request form.

E. Write a final report to the Contractor and Architect, in event of an unexpected incident that occurs during the course of a planned shutdown, resulting in a significant disruption or discontinuance of operations.

F. Interruption of Services: Adequate advance written notice (a minimum of fourteen (14) calendar days) shall be given to the Contractor and Owner's Construction Administrator when interruptions of services, or interferences with the use of existing buildings and roads are anticipated. Contractor’s assigned subcontractor must not interrupt any service without written notice.

G. Planned service shutdowns shall be accomplished during periods of minimum usage. In some cases, this may require work outside of normal 8:00 am to 5:00 pm work hours, at no additional cost to the Owner.
   1. The Contractor or assigned subcontractor must program the work so that service will be restored in the minimum possible time, and shall cooperate with the Owner in reducing shutdowns of system.
   2. At least fourteen (14) calendar days advance written notice shall be given to the Owner's Representative before interruptions to service and other interferences to the use of, or access to existing buildings and facilities.
   3. Required access ways shall be kept open at all times; the use of one way traffic and detours shall be held to a minimum.

3.2 COORDINATION

A. Refer to Document 007200, General Conditions of the Contract for general requirements. Refer to other sections of Division 1 for requirements and timing relating to coordination, as well as other articles of this section.
   1. Submittals: Refer to Section 013300.

2. Quality Control: Refer to Section 014500.
3. Closeout Procedures: Refer to section 017700.
4. Payments: Refer to General Conditions for progress payments and for final payment, as well as requirements of this Section.

B. The General Contractor shall be Project Coordinator and shall coordinate and schedule all work, including with the Owner where the work of the Contract may involve or disrupt the Owner's normal functions.
   1. The Contractor and Subcontractors shall work closely in the coordination of the documents and in the timing of operations.

C. Prime Contractor must provide full-time supervisor on Project at all times during work.

D. Mechanical/Electrical Requirements of General Work: Comply with applicable requirements of Division 23 Sections for Mechanical Provisions within units of General Work, and comply with applicable requirements of Division 26 for Electrical provisions within units of General Work.

E. Service Connections: Except as otherwise indicated, final connection of mechanical services to general work is defined as being mechanical work, and final connection of electrical services to general work is defined as electrical work.

F. Service Shutdowns: Plan shutdowns so as to minimize shutdown time of any service. Request approval of a shutdown in writing to the Owner's Representative not less than fourteen (14) calendar days before the time that the shutdown is desired.

G. Hot Work: Consider hot work similar to utility shut downs and insure proper safety measures are in place. Welding work shall require the same notification procedures as for shutdowns.
   1. Should operations be such that the requested shutdown be delayed in excess of ten working days from receipt of subcontractor’s written request, contract time extension will only be granted for the excess period.
      a. Operation of existing valves, switches, etc. to effect service shutdowns will be made by the Contractor.
   2. Although the general location of services may be shown on the drawings or described elsewhere, neither the Owner nor the Owner's Representative warrant the accuracy of the location shown or described.
   3. Responsibility for determining the actual on-site location of services shall rest solely with the Contractor’s subcontractors.
      a. Each subcontractor must verify the location of all services before commencing work.
      b. All capping, relocation or removal of such services shall be performed by each subcontractor at no increase in contract price.

H. Coordination: The Project will require close cooperation and coordination with Owner and Contractor and Subcontractors. The Contractor must:
   1. Consider such coordination in the work.
   2. Schedule the Work with the subcontractors and the Owner particularly near the end of the Project.
   3. Keep the Owner, and Architect advised of the schedule to complete the Work.

3.3 COORDINATION/ENGINEERING DRAWINGS:

A. Contractor is responsible for providing vertical sections through floors showing structural physical restraints, architectural restraints, plenum spaces and all other physical obstructions that may affect the work.
   1. Provide for integration of the work, including work first shown in detail on shop drawings or product data.
   2. Show sequencing and relationship of separate units of work which must interface in a restricted manner to fit in the space provided, or function as indicated.
   3. Coordination drawings are must be definitive and detailed in nature.

B. Facilitate Coordination Drawing meetings with Subcontractors. Architect will be available, along with applicable engineers, to participate in these meetings as needed.

C. Prepare complete coordination drawings 1/4 inch = 1 foot 0 inches, including plans, sections, details, etc., indicating the complete layout and all mechanical and electrical equipment in all areas and within the ceiling spaces for new and existing conditions, including bottom of duct, pipe, conduit and elevations.

D. Contractor is responsible for coordination of each trades, including General, Mechanical, Fire Protection, Plumbing, Ceiling, Pneumatic Tube System and Electrical Subcontractors.

1. Each of these Subcontractors shall be responsible to ensure that all relevant mechanical and electrical equipment, piping, conduit, ceiling hangers, etc., is shown and will fit.
2. Each Subcontractor must include all necessary items, i.e., lights, ducts, fans, pumps, piping, conduit, etc.

E. Conflicts shall be resolved by the Contractor. Contractor is the primary source responsible for conflict resolution.

F. Electronic reproduction or photo reproduction of Architectural drawings will not be acceptable.

G. Prepare a 1/4 inch sleeving layout indicating size and location of sleeves. Trades shall indicate their requirements and location.

1. Provide copies to applicable trades, Architect and Owner's Representative.

H. At completion of work, coordination drawings shall be submitted together with record drawings of general, mechanical, electrical, plumbing and fire protection trades in accordance with Section 013300 – Submittal Procedures.

I. Review of Coordination/Engineering Drawings is for design intent only and shall not relieve the Contractor from overall responsibility for coordination of all work performed pursuant to the Contract, or from any other requirements of the Contract.

J. Debris Removal and Material Access: An area will be designated for debris removal and material access.

3.4 EQUIPMENT COORDINATION

A. Install equipment in accordance with manufacturers recommendations and instructions.

B. Equipment Coordination: With respect to mechanical and electrical features of Contractor and Owner supplied equipment, complete data must be exchanged directly between the Contractor and those vendors and subcontractors involved as the progress of the Project requires.

1. The person requesting the information shall advise when it will be required.
2. Examine Owner’s existing equipment and determine the rough-in data. Owner will furnish data for equipment purchased by Owner. Owner will disconnect equipment and relocate to new space for connections by Contractor.
3. Consult Owner to verify status of rough-in data.
4. If rough-in details are not available at the time service systems are being installed, postpone final rough-in until data is available.

C. Subcontractors for casework and equipment are expressly required to provide large scale layout drawings for casework and equipment showing the required rough-in locations of all services (dimensioned from building features) service characteristics, and locations of studs where the location is critical to mounting or otherwise installing equipment and casework.

1. Furnish sizes and spacing required for mechanical and electrical cutouts, and a complete brochure of fittings, sinks, outlets, or other information to provide complete data on the items and accessories being furnished.

D. In the event of incorrect, incomplete, delayed or improperly identified information, the entity causing the delay or error shall be responsible and pay for any modifications or replacements necessary to provide a correct, proper and new installation, including relocations required.

E. Services: Rough-in sleeves for waste and other services passing through the floor shall be installed prior to pouring the floors if data is available.

1. Core drilling for holes may be done to facilitate job progress or to more accurately locate holes with permission of the Architect, without additional reimbursement.

F. Sleeves are required at core drilled holes. Where permission is obtained to omit sleeve, drill hole one inch larger than the outside diameter of the pipe or conduit, or one inch larger than outside diameter of insulation, where insulated.
   1. Refer to Section 017324 - Anchorage and Sleeving.

3.5 FIELD DIMENSIONS FOR CASEWORK AND EQUIPMENT

A. Accurate field dimensions are required in ample time to permit fabrication of casework and equipment for delivery and installation in accordance with the schedule.
   1. To obtain dimensions and to prevent fabrication delay, cooperate in completing work phases to accommodate the schedule.

B. Be responsible for obtaining correct field dimensions and informing the various fabricators before start of construction.

3.6 MEETINGS

A. Pre-Construction Meeting: After award of contract, at time designated by the Owner or the Architect, the Contractor and mechanical and electrical subcontractors shall attend a Pre-Construction Meeting.
   1. Procedures to be followed, critical work sequencing, coordination efforts and similar matters will be reviewed.

B. Progress Meetings: During construction, periodic site meetings will be held by the General Contractor with major Subcontractors, Owner, and Architect.
   1. These meetings will be held biweekly (unless job conditions do not warrant) and may be held more frequently if job progress and needs indicate.
   2. Contractor and major Subcontractors shall have one or more responsible representatives in attendance.
   3. Keep the "minutes" of the meeting and distribute the "minutes" to all concerned.

C. In addition to progress meetings specified herein, hold coordination meetings and pre-installation conferences with requisite personnel to assure coordination of Work specified in individual Sections..

3.7 COORDINATION OF SCHEDULES, SUBMITTALS

A. Coordinate schedules, reports, and payments as specified in the General Conditions and Section 013300.

B. Schedule and coordinate submittals specified in Section 013300 and as specified in Section 01770.

C. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate requests for substitutions to assure compatibility of space, of operating elements, and effect on work of other sections.

3.8 COORDINATION OF SPACE

A. Coordinate use of Project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on Drawings.
   1. Follow routings shown for pipes, ducts, and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building.
   2. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

B. In finished areas, except as otherwise shown, conceal pipes, ducts, and wiring in the construction. Coordinate locations of fixtures and outlets with finish elements.

C. Off-Site Fabrication: Off-site fabrication is encouraged as much as possible and deliveries scheduled so materials and equipment can be installed immediately after delivery.

1. Alert and advise others of the need to hold deliveries until they are notified the materials are required on the site.

D. Notice: Give adequate and timely notice of various work phases and operations which will affect the work of, or will require installations or other action by others.

1. After timely notification by the Contractor of the need to accomplish a particular phase or element of the Work, the Subcontractors shall, within a reasonable time, perform their work as not to delay or impede others or the progress of the Project.

E. Coordination of phases of the work: Special coordination and cooperation efforts are required for certain interrelated phases of the work, such as:

1. Sequencing of remodeling work; construction of temporary spaces and facilities; removals and relocations of existing services and facilities; ceiling work; connecting the Owner's equipment; installation of and connections to new utilities; connections to existing buildings; demolition work; providing and maintaining temporary heat and other temporary facilities; and similar work.

3.9 COORDINATION OF CLOSEOUT PROCEDURES

A. Coordinate completion and cleanup of work of separate trades in preparation for Owner occupancy.

B. After Owner occupancy of premises, coordinate access to site by various trades for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

C. Assemble and coordinate closeout submittals specified in Section 01700

END OF SECTION

REQUEST FOR FACILITIES SHUTDOWN

To: _____ Phone: _____

Date: _____

Project Name: _____

Project Number: _____ Project Superintendent: _____

Contractor Requiring Shutdown: _____

Contact Person: _____ Contact Phone: _____

Cell Phone: _____

Type Of Utility Service:

- ☐ Electrical
- ☐ Fire Alarm
- ☐ HVAC
- ☐ Hot Water Heating
- ☐ Steam
- ☐ Condensate
- ☐ Medical Gas
- ☐ Deionized Water
- ☐ Domestic Hot Water
- ☐ Domestic Cold Water
- ☐ Sanitary Sewer
- ☐ Natural Gas
- ☐ Fire Protection
- ☐ Other _____

Work Area Location: _____

Tentative Shutdown Time: _____ Month, Day, Year: _____

Approximate Length of Downtime: _____

Reason for Shutdown: _____

_____

_____

_____

_____

SECTION 013200
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Construction schedule updating reports.

B. Related Requirements:

1. Section 01300 "Submittalls and Permits" for submitting schedules and reports.
2. Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.

1.2 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.

1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF electronic file.

B. Startup construction schedule.

1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

E. Construction Schedule Updating Reports: Submit with Applications for Payment.

1.4 QUALITY ASSURANCE

A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including [phasing] [work stages] [area separations] [interim milestones] [and] [partial Owner occupancy].

4. Review delivery dates for Owner-furnished products.
5. Review schedule for work of Owner's separate contracts.
6. Review submittal requirements and procedures.
7. Review time required for review of submittals and resubmittals.
8. Review requirements for tests and inspections by independent testing and inspecting agencies.
9. Review time required for Project closeout and Owner startup procedures.
10. Review and finalize list of construction activities to be included in schedule.
11. Review procedures for updating schedule.

1.5 COORDINATION

A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from entities involved.
   2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.
   1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
   1. Activity Duration: Define activities so no activity is longer than 30 days, unless specifically allowed by Architect.
   2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
      a. Insert list of major items or pieces of equipment.
   3. Submittal Review Time: Include review and resubmittal times indicated in Section 01300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
   4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
   5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
   6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
   1. Phasing: Arrange list of activities on schedule by phase.
   2. Work under More Than One Contract: Include a separate activity for each contract.
   3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
   4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
   5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 01010 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
   6. Work Restrictions: Show the effect of the following items on the schedule:
      a. Coordination with existing construction.
      b. Limitations of continued occupancies.

c. Uninterruptible services.
d. Partial occupancy before Substantial Completion.
e. Use of premises restrictions.
f. Environmental control.

7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
   a. Subcontract awards.
   b. Submittals.
   c. Purchases.
   d. Fabrication.
   e. Deliveries.
   f. Installation.
   g. Tests and inspections.
   h. Adjusting.
   i. Curing.
   j. Startup and placement into final use and operation.
8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Permanent space enclosure.
   c. Completion of mechanical installation.
   d. Completion of electrical installation.
   e. Substantial Completion.

D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

E. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.

F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and Contract Time.

G. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.2 STARTUP CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit startup, horizontal, bar-chart-type construction schedule within seven days of date established for the Notice to Proceed.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 14 days of date established for the Notice to Proceed. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

2.4 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

PART 3 EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At bi-weekly intervals, update schedule to reflect actual construction progress and activities. Issue schedule 3 days before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

SECTION 013216
CONSTRUCTION PROGRESS SCHEDULES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Scheduling, recording and reporting progress.
   2. Commencement, completion and timing of work.

B. Related Sections:
   1. Refer to General Conditions of the Contract for requirements for commencement of work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 COMMENCEMENT OF WORK

A. No work shall commence at the site until proper bond and insurance evidence has been submitted.

B. Work at Site: Commence work within 14 days of Notice to Proceed as specified.

3.2 PROGRESS

A. Prosecute Work regularly, diligently, without interruption or shutdown and at such rate of progress as will provide Substantial and Final Completion within Contract Time.

B. General Contractor and Subcontractors shall analyze Project, materials and methods involved, systems of the building, availability of qualified mechanics and unskilled labor, restrictions of site, constraints imposed, contractor’s work load and capacity to perform Work and indicate agreement that specified completion, and proposed Project completion times are reasonable considering Project conditions, usual industrial conditions, climatic conditions prevailing in locality of Project, and other factors, with reasonable allowance for variations from average, typical or ideal conditions.

3.3 COMPLETION OF THE WORK

A. Individual Areas: Certain areas and phases of Project are required by Owner to be substantially completed before entire Project is complete, and have more critical requirements for use or occupancy by Owner, to accommodate other phases of Work, to accommodate Owner's services and functions, to provide passages to various adjacent buildings, to maintain services and functions of various departments and to coordinate with other construction.
   1. The sub-completion times for various areas or phases, as specified or as later developed in Contractor's Construction Schedule, shall be essential conditions of Contract, as well as completion of entire Project.

B. Completion of Areas: At space or area specified, or later scheduled, to be occupied or used by Owner before entire Project is complete, elements and systems of Work shall be substantially complete by scheduled time.
   1. Systems shall be tested, balanced or otherwise placed in full and proper operating condition.

C. Substantial Completion Date: As agreed upon between Owner and Contractor and entered into Agreement.

D. Time Set by Schedule: Where constraints, completion and timing of Work specified in this or other Sections do not have specific dates or time imposed by Contract Documents, they shall be considered and incorporated as established dates in final Construction Schedule of Contractor.

1. Where the activity affects Owner, time or dates established in Construction Schedule shall be maintained, as Owner will plan activities accordingly.

E. Other Considerations: In addition to time of commencement, substantial completion and final completion dates, other events, factors, and constrains shall be carefully considered in establishing work progress and schedule for Project.
   1. Contractor and subcontractors shall work closely in timing of operations and shall have materials, equipment and other elements ready to be able to immediately fulfill their obligations in the overall schedule.

F. Final Completion: Within 30 days after Substantial Completion date.

G. Contract Conditions: Commencement of work and the time of completion shall be essential conditions of the Contract.

3.4 TIMING OF WORK

A. It is essential that full Owner's services and functions are maintained throughout construction period, with minimum disturbance and disruption to operations, departments and staff.
   1. Contractor, subcontractors and workers shall be aware of these requirements and objectives.
   2. Conduct work and develop detailed schedule to meet these requirements and objectives.

B. Owner's Relocations: Owner will temporarily or permanently relocate departments, parts of departments, functions and staff as may be necessary to accomplish new work and remodeling.
   1. However, space is at a premium and Owner's functions will impose constraints and limitations on extent and manner in which relocations can be accomplished.

C. Sequencing: Work sequences by various phases or areas form the basis for the logic of Contractor's construction schedule. Sequencing has been developed with Owner to permit new construction and remodeling to be accomplished while maintaining services and functions with a minimum of disturbance.
   1. It shall be recognized that unanticipated difficulties may arise, unanticipated conflicts in timing may occur or that Contractor will be able to develop alternatives which will benefit Project, timing of Work or Owner.
   2. In such event, propose or develop with Owner, alternatives for acceptance by Owner in advance, which will improve Project and its progress.

3.5 CONSTRUCTION PROGRESS SCHEDULE AND CONSTRAINTS

A. General: Refer to the General Conditions of the Contract. Location and nature of Project, requirement to maintain operation, functions and services of Owner dictate careful planning, scheduling and close cooperation with Owner, with close coordination by Contractor, subcontractors and Owner.
   1. Keep Owner advised of intended operations and schedule and be guided by other constraints or timing of work that may develop during construction, as instructed by Owner.
   2. It is intent of Owner to cooperate as far as possible to minimize hampering of operations and Contractor may suggest schedules and timing which will facilitate progress.

B. Construction Schedule: Within 14 days after award of Contract, prepare proposed initial detailed Construction Progress Schedule for review with Owner and Architect.
   1. In general, schedule shall indicate various phases of work but coordinated and integrated time-wise with other work.
   2. The schedule shall also indicate various activities of each area, stage and phase of work, with integrated and coordinated commencement and completion times.
   3. After review by Owner, including revised sequencing proposed by Contractor or Owner to improve progress or minimize disruption of Owner's functions, revise schedule as "final" schedule, which will provide planning information for Owner's relocations and other operations.

C. Schedule Revisions: If necessary during construction due to additional proposed improvements, unanticipated conflicts or other conditions, revise schedule as often as may be required in a manner approved by Owner, to keep Owner constantly advised as to dates of various activities.
   1. Copies of revised schedules shall be provided Owner and Architect.

D. Services: At no time shall existing services, utilities and systems be shut down or interrupted without advance notice to, and approval of, the Owner. Required interruptions or change-overs shall be scheduled and performed at times when interruption will not interfere with Owner's operations, as determined by Owner; anticipate such interruptions and change-overs will be accomplished after normal working hours and/or weekends.

E. Construction Access: Except as approved by Owner, access to the additions and remodeled areas shall be directly from outside, rather than through existing building.

F. Demolition work within existing spaces: Employe construction practices during demolition to minimize the production of dust, such as wet cutting of concrete slabs and masonry and water misting of rubble. Contractor to use dust compound when sweeping.

G. Preparation for Work in Existing Spaces: Assemble materials and equipment, including that of subcontracts, and subcontractors committed to a firm schedule, prior to commencing work to accomplish work as expeditiously as possible.
   1. Each Subcontractor must obtain approval of Contractor before starting work within existing building.
   2. After work commences in existing space, continue without interruption to completion, except where work phases require otherwise or Owner's relocations temporarily suspend the work.

END OF SECTION

SECTION 013223
SURVEY AND LAYOUT DATA

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Survey and sub-surface investigation requirements.

B. Related Sections:
   1. Section 312000 – Earth Moving.

1.2 SUBMITTALS

A. Survey: Submit certified survey as part of record documents under Section 01700 – Cleaning and Project Closeout Submittals.

1.3 QUALITY ASSURANCE

A. Land Surveyor: Registered in State in which project is located and acceptable to Owner.

PART 2 PRODUCTS

2.1 SURVEY

A. Provide construction survey work required for accurate location of Work. Horizontal and vertical control for work shall be from project reference marks as shown on Drawings. Verify final configurations of project.

B. A copy of Owner's site survey is available for examination by Contractor.

PART 3 EXECUTION

3.1 INSPECTION

A. Verify locations of survey control points prior to starting work. Promptly notify Owner of discrepancies discovered.

3.2 PROJECT SURVEY REQUIREMENTS

A. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means:
   1. Site improvements.
      a. Stakes for grading, fill and topsoil placement.
      b. Utility slopes and invert elevations.
   2. Batter boards for structures.
   3. Building foundation column locations and floor levels.
   4. Controlling lines and levels required for mechanical and electrical trades.

B. From time to time, verify layouts by same methods.

3.3 SOIL BORING INVESTIGATION

A. Site plan indicates approximate location of test borings put down only for Architect's design purposes by the testing laboratory.
   1. Copy of boring logs of report may be examined during normal business hours at Architect's office. Upon request, a copy may be obtained from Architect.
   2. Reports or information contained therein is not part of Contract Documents. Information obtained, or conclusions reached, from reports including boring logs is at examiner's own risk.

B. Information therein is not guaranteed by Owner, Architect, or Laboratory, nor shall it be construed as representing typical or actual conditions of site nor being indicative of site conditions, other than at boring locations.

END OF SECTION

SECTION 013233
PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Preconstruction photographs.
   2. Periodic construction photographs.
   3. Final completion construction photographs.

B. Related Requirements:
   1. Section 01300 "Submittal Procedures" for submitting photographic documentation.
   2. Section 01700 "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.

1.2 INFORMATIONAL SUBMITTALS

A. Digital Photographs: Submit image files within three days of taking photographs.
   1. Digital Camera: Minimum sensor resolution of 8 megapixels.
   2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
   3. Identification: Provide the following information with each image description in file metadata tag:
      a. Name of Project.
      b. Name of Contractor.
      c. Date photograph was taken.
      d. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
      e. Unique sequential identifier keyed to accompanying key plan.

1.3 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.

PART 3 EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
   1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
   1. Date and Time: Include date and time in file name for each image.
   2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.

C. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.

1. Flag excavation areas before taking construction photographs.
2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

D. Periodic Construction Photographs: Take 20 photographs monthly, coinciding, with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

   a. Commencement of the Work, through completion of subgrade construction.
   b. Above-grade structural framing.
   c. Interior Work, through date of Substantial Completion.

E. Final Completion Construction Photographs: Take 20color photographs after date of Substantial Completion for submission as project record documents.Architect will inform photographer of desired vantage points.

END OF SECTION

SECTION 014200
REFERENCES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reference to standards and codes.

B. Related Sections:
   1. General Conditions.
   2. Section 016210 - Product Options and Substitution Requirements.

1.2 DEFINITIONS

A. "Approved": The term "approved," when used to convey Architect's action on Contractor's submittals, applications, and requests, is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

B. "Directed": Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by Architect, requested by Architect, and similar phrases.

C. "Indicated": The term "indicated" refers to graphic representations, notes, or schedules on Drawings or to other paragraphs or schedules in Specifications and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the user locate the reference.

D. "Regulations": The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

E. "Furnish": The term "furnish" means to supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

F. "Install": The term "install" describes operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

G. "Provide": The term "provide" means to furnish and install, complete and ready for the intended use.

H. "Installer": An installer is the Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

I. The term "experienced," when used with an entity, means having successfully completed a minimum of 5 previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

J. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.

K. "Project site" is the space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 APPLICABLE GOVERNING STANDARDS

A. Code Overview: Code plans identifying Occupancy Types, Occupant Loads, Construction Type and Exiting Components should be consulted for additional information.
   1. City of Milwaukee

a. Municipal Building Code
b. City Zoning Code

2. Applicable State Building Code:
   a. 2009 International Building Code with Wisconsin Amendments.
3. Fire Code:
   a. Wisconsin Fire Code, SPS 319 reference to NFPA and U.L. Fire Resistance Index.
4. Mechanical Code:
   a. 2009 International Mechanical Code with Wisconsin Amendments
5. Energy Code:
   a. Wisconsin State Energy Code, SPS 363, latest edition.
6. Plumbing Code:
   a. Wisconsin State Plumbing Code, SPS 381 - 387, latest edition.
7. Electrical Code:
   a. Wisconsin State Electrical Code, SPS 316 and PSC 114 by reference adopting National Electrical Code (NEC), latest edition.
8. Accessibility Code:
   a. ICC/ ANSI Standard A117.1-2003 as referenced by the IBC 2009. ADA guidelines are used where these are more stringent and not in conflict with code requirements.
9. Life Safety Code:
   a. NFPA Life Safety Code 101 - 2000 edition, is consulted when building code is silent on an issue.
10. OSHA: Occupational Safety and Health Standards that adopts by reference the Federal Occupational Safety and Health Standards Code as required.

1.4 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

C. Conflicting Requirements: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.
2. If Contractor knowingly performs Work contrary to such laws, ordinances, rules and regulations without notice to Architect, consequent costs and damages will be paid by Contractor.

D. Copies of Standards: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

E. Certificate: For products specified in accordance with a Federal Specification, ASTM Standard, American National Standards Institute or similar association standards, upon request by Architect, the Contractor must provide an acceptable affidavit by independent testing laboratory, or other source approved by the Architect, certifying that product furnished for this Project complies with the particular standard specifications.

1. Where necessary, requested or specified, supporting test data shall be submitted to substantiate compliance. The manufacturer is subject to Architect's acceptance.

F. Abbreviations and Acronyms for Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

END OF SECTION

SECTION 014500
QUALITY CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Procedures to measure and report the quality and performance of construction.

B. Related Sections:
   1. Refer to the General Conditions for general requirements, and technical specifications for specific testing requirements and methods.
   2. Section 01300 - Submittal and Permits.

1.2 REFERENCES

A. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

B. ASTM E329 – Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.3 QUALIFICATIONS OF TESTING AGENCY

A. "Approved independent testing laboratory" shall mean an independent testing agency acceptable to the Owner and the Architect and possessing the professional qualifications and equipment to perform the specified tests and to evaluate and report the results.

1.4 QUALITY ASSURANCE

A. Comply with requirements of ASTM E329 and ASTM D3740.

B. Laboratory shall maintain a full-time registered Engineer on staff to review services.

C. Laboratory authorized to operate in State in which Project is located.

D. Testing equipment shall be calibrated at reasonable intervals with devices of an accuracy traceable to either NBS Standards or accepted values of natural physical constants.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 TESTING AND SPECIAL TESTING

A. Unless otherwise provided in the specifications, provide all materials, samples, mock-ups or assemblies for all tests specified in various sections of specifications, or as directed by the Architect, and pay shipping costs of such samples to laboratory or other testing location and facility.
   1. Unless specified otherwise, all tests shall be made by an approved independent testing laboratory and reports provided to Architect.

B. Tests shall be provided and accomplished in accordance with the standard used as the reference for the particular material or product, unless other test methods or criteria are specified.

C. In the absence of a referenced standard, tests shall be accomplished in accordance with applicable ASTM Standards or Test Methods, current at the date of the Contract Documents.

3.2 PAYMENT FOR TESTS

A. Unless otherwise indicated, the cost of tests shall be paid by the Contractor.

3.3 PAYMENT FOR TESTS

A. Except for the types of tests specified as being paid for by the Owner, the cost of other tests shall be paid by the Contractor. Tests to be paid for by the Owner will be paid directly to the testing laboratory by the Owner.

B. The Owner will not pay for tests to determine if a proposed material will initially meet the specified requirements, which will include but not be limited to, analysis of paving aggregate, paving mix designs, and similar tests.

C. In general, it is intended the Owner will pay for those field tests to determine the quality of materials and quality of installation at site. The following is the list of the type of tests the Owner will pay for, where tests are specified or later determined as necessary:

- concrete compressive strength
- concrete air entrainment
- soil compaction
- structural steel field welds
- structural steel bolting
- welding or brazing of piping
- paving samples
- unit masonry sampled from site
- mortar samples
- fireproofing samples

3.4 TESTS TO DEMONSTRATE QUALIFICATION

A. In addition to tests specified, should the Contractor propose a product, material, method or assembly that is of unknown or questionable quality to the Architect, the Architect may require and order suitable tests to establish a basis for acceptance or rejection.

1. Such tests will be paid for by the Contractor, or by the Subcontractor requesting approval. "Standard" test reports on "similar" material will not be acceptable.

B. The Owner and Architect reserve the right to require certification or other proof that the material, assembly, equipment, system or other product furnished or proposed to be furnished, for this Project is in compliance with any test or standard called for.

1. The certificate shall be signed by a representative of the independent testing laboratory.

C. Any tests required to qualify the Contractor or any workmen for any phase of the work, and any test of a method, system or equipment that may be required by specification or law to qualify the item for use, shall be made or taken without additional reimbursement.

D. If exploratory work is required to determine the cause of defects, the cost of such work shall be borne by the Contractor responsible for such work if the work is found, in the judgement of the Architect to be defective.

1. If the Contractor responsible for the work is adjudged by the Architect to be not at fault, exploratory testing will be paid by the Owner.

3.5 INSPECTIONS

A. Should the specifications, Architect's instruction, laws, ordinances or any public authority require any work to be inspected or approved, give timely notice of its readiness for inspection and a reasonable date fixed for such inspection. If any work requiring inspection should be covered up without approval or consent of the approving agency, it must be uncovered for examination at Contractor's expense.

3.6 CERTIFICATES

A. Except for test reports provided and signed by approved independent testing laboratories, all certificates required by the specification shall be signed by an authorized official of the firm providing the certificate, with the signature notarized, when such certificates by the producer are acceptable to the Architect.

3.7 RETEST RESPONSIBILITY

A. Where results of required inspections, tests or similar prove unsatisfactory and do not indicate compliance of related work with requirements of the contract documents, then retests are responsibility of Contractor, regardless of whether original test was Contractor's responsibility.

B. Retesting of work revised or replaced by Contractor is Contractor's responsibility, where required tests were performed on original work.

END OF SECTION

SECTION 015110
TEMPORARY UTILITIES (SF)

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for utilities used on the site during construction.

B. Related Sections:
   1. Section 015210 - Construction Facilities.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 TEMPORARY HEAT AND VENTILATION

A. Owner will provide heat and ventilation through existing sources. Additional ventilation, such as fans, shall be provided by the Contractor who's work necessitates such ventilation.

B. Filters: Mechanical Subcontractor is responsible for providing, maintaining, cleaning and replacing all filters, both temporary and permanent.
   1. New permanent filters shall be installed just before Owner occupies or accepts the Project.
   2. Temporary filters shall be installed and maintained during construction period, after enclosure, so that at all times the duct systems are protected from an accumulation of dirt or dust, as a result of this contract.
   3. Where necessary to prevent the spread of dirt and dust to ductwork, at areas which are enclosed or areas where finishing operations are in progress, filters shall be installed by Mechanical Subcontractor in temporary or permanent locations.

3.2 TEMPORARY POWER AND LIGHT

A. General: Power for construction purposes will be furnished by the Owner through existing electrical panels provided the privilege is not abused. Excessive use of electricity will not be permitted.
   1. The Owner will have priority on the use of electricity. Do not exceed service.

B. Wiring and Devices: The Electrical Contractor must provide temporary wiring, outlets, lamps, devices and connections as defined in Division 26. Installation service, wiring and devices shall be safe, substantially supported and adequately connected.
   1. Demand shall not exceed the service and any damage resulting from misuse, faulty equipment or overload shall be paid for by responsible persons.

C. Heavy Loads: Energy costs and services for testing of equipment as well as for welders, grinders, pipe threaders and similar heavy loads requiring power greater than building service shall be provided and paid for by Contractors requiring such service and they shall arrange and pay for their own service.

3.3 CONSTRUCTION WATER

A. Source: The Owner will permit the free use of water from existing services, provided the privilege is not abused. Needless running of water will not be permitted.

B. Services: Contractor (and Subcontractors where appropriate) shall provide their own hoses (or piping), connections and other equipment to use water and protect their own equipment.

1. When water is being used, the service shall be protected from freezing and damage at all times. Any damage shall be remedied at once paid for by the Contractor.

3.4 TELEPHONE

A. Contractors shall use their own cell phones for the project and include those costs including use charges with their bid for the work.

END OF SECTION

SECTION 015210
CONSTRUCTION FACILITIES (SF)

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for facilities used on site during construction.

B. Related Sections:
   1. Section 015110 - Temporary Utilities.

1.2 SUBMITTALS

A. Schedules and Layouts: Submit schedule of construction facilities required and layout of site offices and storage enclosures.

1.3 QUALITY ASSURANCE

A. Standards:
   1. NFPA 241 Standard for Safeguarding Construction, Alterations, and Demolition Operations,
   2. ANSI-A10 Series Standards for Safety Requirements for Construction and Demolition,
   3. NECA Electrical Design Library Temporary Electrical Facilities.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used.

B. Lumber and Plywood: Comply with Section 061000 - Rough Carpentry, for requirements.
   1. UL labeled, lumber and plywood for framing, sheathing and siding.
   2. Exterior type, Grade BB high density concrete form overlay plywood for signs and directory boards.

C. Roofing Materials: UL Class A standard weight asphalt shingles or UL Class C mineral surfaced roll roofing on Job-built temporary shops and sheds.

D. Paint: Comply with Section 099000 - Painting, for requirements.
   1. Provide exterior-grade alkyd gloss enamel over exterior primer for sign panels and applied graphics.

E. Fire-rated Partitions for Temporary Enclosure: Provide rated gypsum board wall construction meeting requirements of local jurisdiction for use as temporary enclosure.

F. Tarpaulins: Waterproof, fire-resistant, UL-labeled tarpaulins with flame spread rating of 15 or less. Provide translucent, nylon-reinforced laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins certified as conforming to the test results of test method 2 contained in NFPA 701, entitled Standard Method of fire Tests for Flame Propagation of Textiles and Films unless local jurisdiction accepts test method 1 of NFPA 701 or requires other materials.

PART 3 EXECUTION

3.1 OFFICES

A. Maintain an office at the site suitable for storing of records and for conferences. Office may be prefabricated or mobile unit with lockable entrance, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.

1. Maintain copy of contract documents, shop drawings, correspondence, Architect's directions 1. Maintain neat housekeeping. Keep separate bound files, kept neat and up-to-date. Only shop drawings accepted by Architect shall be kept on file.

3.2 SANITARY FACILITIES

A. Provide an adequate number of temporary toilets during construction for use of all trades. Toilets shall be flushing or portable self-contained type, well maintained and be screened from view. Provide units properly vented and fully enclosed with glass-fiber reinforced polyester shell or similar nonabsorbent material.
   1. Maintain adequate supply of tissue.

B. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.

3.3 STORAGE AND ENCLOSURES

A. The Contractor and each Subcontractor shall provide locked storage and enclosures to protect and preserve the materials stored at and off the site. Materials such as wood, metal, cement, masonry materials, equipment of any type, conduit and similar materials, shall not be piled directly on ground.
   1. Coverings shall be durable, watertight (fully cover sides as well as top) substantial and well anchored to prevent blowing away 2. Shed type of enclosures shall be provided for easily damaged and small items. Any protection which becomes damaged shall be replaced immediately A. Without exception, fan units and all other equipment with bearings or similar working parts shall be set on supports above the ground and snow and shall be enclosed with substantial and well secured waterproof protection.

B. All storage facilities shall be neatly constructed and maintained, including protective covering. Loose or inadequate coverings shall be immediately replaced.

C. Any temporary enclosures of the building shall be neatly fabricated, durable, and maintained in good condition.

D. When storage or enclosure facilities are no longer required, they shall be removed from the site by the Contractor.

E. If required for exterior storage, provide a temporary 8 foot high chain link fence enclosure with lockable gates.

3.4 SIGNS

A. Office Sign: The Contractor or Subcontractor may provide a sign to identify office.

B. No other signs permitted, including signs on structure.

3.5 FIRE EXTINGUISHERS

A. Hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. Provide UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for possible exposures encountered.
   1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

3.6 BARRIERS

A. Provide as required to prevent public entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.

B. Provide barricades and covered walkways as required by governing authorities for public rights-of-way and to public access to existing building.

C. Provide barriers around trees and plants designated to remain. Protect against vehicular traffic, stored materials, dumping, chemically injurious materials, and puddling or continuous running water.

3.7 TEMPORARY CLOSURES AT NEW AND EXISTING BUILDINGS

A. Interior Openings: Temporary closures at interior openings shall provide protection from the transfer of dust and security of materials and equipment. Perimeters and penetrations shall be sealed with masking tape, caulk or other appropriate seal to eliminate passage of dust. Closures shall be well maintained to protect against dust and to provide security.

3.8 ROUTING

A. For removal of debris and delivery of new materials to the site, coordinate with Owner.

3.9 MASONRY CUTTING AND MORTAR MIXING AREA

A. Location shall be reviewed with and approved by Owner.

3.10 PARKING

A. Parking for construction personnel is not provided. Required temporary parking for delivery of materials shall be as directed by Owner.

3.11 FIRE SAFETY DEVICES

A. General: Refer to Section 01010 for general requirements and for Fire and Safety Director.

B. Fire Extinguishers: Except for units in individual Contractors' offices, provide and maintain adequate and proper fire extinguishing devices in and about the construction area, available for use by all workmen. The devices shall not be the units to be later installed in the Project. Appropriate devices shall be provided for the class of the potential hazard (e.g. oil, electrical) at those areas where unusual hazards may exist, including in mechanical rooms. As construction proceeds, or materials which create a hazard are moved onto various floors, extinguishing devices shall be available on each floor. The number and distribution of devices shall be adequate for effective fire control, to the satisfaction of the Fire Safety Director and the Owner.

C. Fire Hydrants: The area fire hydrants must be accessible at all times. Fences and construction work must be arranged and accomplished to provide immediate access to hydrants.

END OF SECTION

SECTION 016210
PRODUCT OPTIONS AND SUBSTITUTION REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Procedures, requirements and limitations for considering substitutions.
   2. Criteria for selecting product options and substitutions.

1.2 SUBMITTALS

A. Submit requests for substitution in writing to Architect at least 10 calendar days prior to bid date and hour. Requests received after this time will not be considered.

B. Clearly define and describe proposed substitute product including following items:
   1. Fully completed Section 016211 - Substitution Request Form.
   2. Manufacturer's printed information supporting claim that proposed product meets specified requirements. Provide following as applicable:
      a. Literature Specifications Drawings Cut Sheets Performance data List of reference projects of similar size, value and complexity Model numbers Other information necessary to completely describe item.
   3. Provide a point by point comparison between key features of specified Basis of Design item and proposed substitution.
   4. Provide submitted materials marked with Article and Paragraph references from Specification using highlighter, marker and flags on pages to facilitate review and show that substitution meets specified requirements.
   5. Provide a letter indicating requestor has reviewed Contract Documents and examined site (if needed) and that proposed substitution meets specified requirements.

C. Accepted substitutions will be published in writing. No information or indication of acceptance will be provided by means other than written Addendum during bidding or Architect’s written construction administration document following bidding. Refer to “Limitations on Substitutions after Bids or During Construction" in this Section.

D. Bid and construct according to Contract Documents unless approval of substitution is provided in writing.

E. Architect is not obligated to state reasons for rejecting substitution.

1.3 DEFINITIONS

A. "Product" means material, equipment, assembly, system, manufacturer, brand, trade name, element, item or similar as applicable.
   1. Provide new products free from defects and deficiencies unless otherwise noted.
   2. Provide components and accessories necessary for a complete system by same manufacturer unless otherwise specified.

B. Terms such as “approved substitute”, "equal to", "accepted by", "approved by", or other synonymous terms mean that acceptance of proposed product is subject to approval by Architect after submittal requirements are met. Architect’s decision is final and binding.

C. Available Manufacturers: See below.

D. Except where "no substitutions", "same as existing" or "match existing" are noted, term "or approved substitute" is implied throughout, subject to prior approval conditions specified including where the term "Available Manufacturers" is included.

PART 2 MATERIALS

2.1 PRODUCTS

A. Architect and Owner reserve right to accept or reject proposed product. Should a proposed product be unable to meet requirements to satisfaction of Architect, product shall not be used. No additional compensation will be allowed for required Work resulting from use of product accepted by Addendum.

B. Use only one brand, manufacturer, source or type for like products unless otherwise approved or specified. Contractor is obligated to do so unless otherwise approved in writing.

C. Provide pricing based on products listed in Contract Documents. Contract award is based on use of specified products or substitutions approved prior to bidding or pricing.

1. By execution of Contract, Contractor agrees and understands Work will be accomplished with products specified or accepted by substitution.

D. Basis of Design Products:

1. Reference to "Basis of Design" and a named specific product or manufacturer is intended to establish criteria for use of that product and manufacturer based on that products published information whether or not those criteria are explicitly stated in Specifications.
2. Criteria may establish higher performance requirement than specified reference or performance standards. Such reference is intended to establish minimum level of quality, standard of design, function, appearance, type, strength, durability, construction, efficiency, sound level, finish, appearance, availability, service and similar characteristics determined necessary for Project.
3. Specification criteria including basis of design products are considered as a whole.
4. Other products or manufacturers listed meet features, performance, appearance and other criteria established by that product or manufacturer even if product must be customized to meet those criteria.
5. When other products are listed in a Section those products may be used if they meet entire specification criteria including criteria implied by product listed as basis of design. Meeting some requirements but not meeting criteria established by basis of design product does not qualify as meeting specified requirements.
6. Products or manufacturers accepted for substitution will be acceptable provided they fully comply with requirements and match basic and essential criteria of product used for basis of specification or design, including level of fabrication quality, as determined by Architect.

E. Reference Standards for Products:

1. When references to Federal Specification, ASTM Standard, American National Standards Institute (ANSI) or similar association standards are listed for product quality, provide an acceptable affidavit certifying that proposed substitution for this Project meets with same standard.
2. Submit supporting test data to substantiate compliance.

F. Substitute products shall:

1. Be available in same range of colors, textures, dimensions, gauges, types, and finishes as specified product.
2. Be equal to specified item in strength, durability, efficiency, serviceability, ease and cost of maintenance.
3. Be compatible with building design.
4. Not necessitate design modifications.
5. Not impose additional work or require changes in work of Prime Contractor, or other Subcontractor, vendor, or materials supplier.
6. Not add cost to Owner.
7. Be similar in essential fabrication features.

G. Contractor, supplier or manufacturer providing accepted substitute product shall bear cost of required modifications to spaces, services, utilities and other features as result of accepting substitute products, including but not limited to:

1. Larger capacity mechanical or electrical service, devices or utilities resulting from acceptance of product for bidding purposes.

2. Modification to pipes, conduits, ducts, and controls for conveying, distributing, and controlling those services or utilities.
3. Modification to insulation, wrappings, coatings, or other integral features of lines or items conveying those lines.

H. Timely Placement of Product Orders: Place product orders in a timely manner, within ten days after acceptance of submitted list of materials.

2.2 LIMITATIONS ON SUBSTITUTIONS AFTER BIDS OR DURING CONSTRUCTION

A. Intent is to limit unnecessary substitutions after bids. Changes will not be allowed to accepted list of products, except when specified or accepted product subsequently is determined as not meeting requirements of Contract Documents or product becomes unavailable, and then only under following conditions:

1. Orders were placed in timely manner as required after list of materials is accepted. No excuse or proposed substitution will be considered for products due to unavailability unless proof is submitted that firm orders were placed in a timely manner.
2. Reason for unavailability is beyond control of Contractor: prolonged strikes or lockouts which will delay Project to an extent unacceptable to Owner, bankruptcy, discontinuance of a product, delays or Acts of God or other similar reasons.
3. Request for substitution is submitted in writing within 10 days after date Contractor becomes aware product does not comply with specifications or has become unavailable, accompanied by supporting evidence.
4. No extra cost to Owner.
5. Substitution does not compromise design intent or quality required.
6. Substitute product is acceptable to Owner and Architect.
7. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
8. Requested substitution does not require revisions to Contract Documents.
9. Requested substitution is consistent with the Contract Documents and will produce intended and indicated results.
10. Substitution request is fully documented and properly submitted.
11. Requested substitution will not adversely affect Contractor's Construction Schedule.
12. Requested substitution has received necessary approvals of authorities having jurisdiction.
13. Requested substitution is compatible with other portions of Work.
14. Requested substitution has been coordinated with other portions of Work.
15. Requested substitution provides specified warranty.
16. If requested substitution involves more than one trade, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to installers involved.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 016211
SUBSTITUTION REQUEST FORM

To: **Hammel, Green and Abrahamson, Inc.**
333 East Erie Street
Milwaukee, Wisconsin 53202
Attention: Matthew Mikolainis

Project: City of Milwaukee – Northwest Garage
Compressed Natural Gas Fueling Station

HGA Comm. No.: 1203-005-03 **Date Received:** _____

Specification Section Number and paragraph: _____

Drawing and details affected: _____

Proposed Substitution: _____

Manufacturer: _____

Product (model, pattern, etc.): _____

WHY IS SUBSTITUTION BEING SUBMITTED? (Select one of the following):

- ☐ Pre-Bid Substitution (Prior Approval) Bid Date:
- ☐ Specified product is not available. Explain.
- ☐ Cost savings to Owner. Indicate comparative cost analysis.
- ☐ Other: Explain.

EFFECTS OF PROPOSED SUBSTITUTION: Answer the following questions and attach explanations.

Does substitution affect dimensions indicated on Drawings?
☐ NO ☐ YES, explain:

Does substitution affect Work of other Sections?
☐ NO ☐ YES, explain:

Does substitution require modifications to design, changes to Drawings, or revisions to specifications to be incorporated into the Project?
☐ NO ☐ YES, explain:

Attach list of at least 3 projects where proposed substitution has been used within past 12 months; include name, address, and telephone number of Owner and Architect.

CONTRACTOR'S / BIDDER'S REPRESENTATION

Undersigned accepts responsibility for coordination of proposed substitution and accepts all additional costs resulting from the incorporation of proposed substitution into the Project per Section 016210.

SUBMITTED BY:

_____

_____

Fax No: _____

For Architect's use:
☐ Accepted ☐ Not Accepted
☐ No Action Required
☐ Submission: Incomplete
☐ Too Late
Reviewed by/date: _____
Comments: _____

Subcontractor's signature and date: _____

Contractor's signature and date: _____

SECTION 017324
ANCHORAGE AND SLEEVING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:
   1. General Procedural Requirements.
   2. Installation of proper anchorage devices to securely fasten hang, mount, anchor, and support all work.
   3. Rough-in and installation of Equipment.

B. Related Sections
   1. Section 017329 - Cutting and Patching.

1.2 TESTING

A. Under supervision of an independent testing laboratory paid by for by the Owner, 5 percent of anchors shall be field loaded above anticipated loads to insure their adequacy.
   1. Drilled-in expansion anchors, which have the same hole size as the bolt size, such as "Kwik-Bolt" or "Wej-It" or "Thunderstud" by Universal Fastenings will be permitted provided:
      a. There is no spalling around the holes,
      b. The holes are neatly drilled and approved test reports indicate adequate shear and pullout strength with ample safety factor.

PART 2 - PRODUCTS

2.1 TYPES OF ANCHORAGE AND SLEEVING DEVICES

A. New Materials: As specified in individual Sections, or as herein specified.

B. Existing Materials: Match existing products and work for anchoring and sleeving unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which anchorage and sleeving work is to be performed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Methods and devices, as well as location, may be subject to Owner Representative's approval and shall not impair, violate or alter structure, water integrity or aesthetic value of the Work. Sleeve existing pipes indicated.

B. In general, provide bolts and shields for anchorage to solid materials, toggle bolts into hollow construction or through bolts and washers where necessary, unless otherwise shown or specified.

C. Provide sleeves for all pipes, ducts and similar features that pass through walls, slabs, concrete joists, beams or girders, concrete columns or concrete bridging, whether specifically indicated or not.

D. Provide adequate backing for all fastenings and supports to prevent deflection or undue stresses. For concrete, anchorage devices shall generally be cast in, not drilled in later, unless otherwise specified in individual section of work.

3.3 ANCHORS

A. Furnish and install proper anchorage devices to securely fasten, hang, mount, anchor, and support work substantially.

B. Wood plugs into solid materials, toggle bolting to lath and plaster, or bolting into shields at hollow units will not be acceptable.

C. Shot and Drilled Anchors: At concrete, shot or drilled-in anchor devices will be permitted where casting in may be difficult to coordinate, provided they will not damage the concrete or cause any spalling around the anchor.

D. Shot anchors will not be permitted in bottoms of joists, in post-tensioned slabs where cable location is unknown, in slabs 4 inches or less in thickness, nor where spalling may result.

E. Any shot anchors at concrete joists shall be at the side of the joist, above centerline, located to avoid reinforcing steel. Verify shot anchors at composite decking with the Owner's Representative.

3.4 SLEEVES

A. Sleeves shall be of new material, cut square, reamed. Sheet metal sleeves may be used only where specifically approved.

1. At all concrete penetrations, sleeves shall be uncoated or galvanized pipe, not less than Schedule 40 steel pipe.
2. At exposed or concealed masonry walls, sleeves shall be the same as for concrete penetrations.

B. Unless otherwise called for, sleeves passing through walls, slabs, beams, bridging, columns, shall be 1/2 inch greater in inside diameter than external diameter of pipe passing through sleeves, or the insulation diameter.

1. Pipe insulation shall be continuous through the sleeves.

C. Unless otherwise called for, sleeves through walls shall extend full thickness of wall and be cut flush with finished surface; sleeves through exterior building walls, above or below grade, shall extend full thickness of wall and be cut flush with finished surfaces; sleeves through floor slabs for exposed piping shall extend not less than 1/2 inch above finished floor.

D. Sleeve Spacing: Where sleeves occur in rows or clusters, a minimum of 4 inches of concrete shall be left between sleeves and if the normal spacing of reinforcing bars cannot be maintained, or are interrupted because of sleeve size or cluster location, extra reinforcing shall be provided by the Contractor as directed by the Owner's Representative. In no case shall sleeves impair the structural capability of the Work.

E. Sleeves at Core Drilled Holes: The sleeves shall provide a good fit to core drilled hole and shall be set in place with a full coating of epoxy adhesive to insure remaining in place and a good seal between the hole and the sleeve. Do not core drill post-tensioned slabs.

F. Sealing of Sleeves: As pipe, conduit or other feature is installed through a sleeve, it shall be wedged to keep in the center of the sleeve, with wedges held 1" back from end of sleeve. Pipe, conduit or other features through walls or other vertical surfaces, shall be caulked at the top in all cases, and at the bottom where exposed in a finished space.

3.5 EQUIPMENT LAYOUTS, ROUGH-IN AND INSTALLATION

A. Unless specifically noted, equipment shall be installed in accordance with the manufacturer's recommendations and instructions.

B. Full layout data and rough-in data is to be provided by the Contractor or subcontractor supplying the equipment, to others requiring the data, in sufficient time to facilitate proper and accurate rough-in.

1. For existing equipment of the Owner, the Contractor must examine the equipment and determine the rough-in data. For equipment to be purchased by the Owner, the Owner will arrange to have the data furnished to the Contractor.

2. If rough-in details are not available at the time service systems are being installed, the final rough in shall be postponed until the data is available. At all times prior to roughing-in for equipment by Owner, consult with the Owner to verify the status of rough-in data.

C. Floor Sleeves: For waste and other services passing through the floor, if rough-in data is available, it is the intent that the rough-in sleeves generally, shall be installed prior to pouring the floors.
   1. With the permission of the Owner's Representative, core drilling for other holes (even if data is available) may be done to facilitate job progress or to more accurately locate the holes, with such core drilling done without additional reimbursement.
   2. If layout information for rough-in sleeving for equipment provided under the construction Contract is not available at the time sleeving through the floor must be accomplished, core drilling later shall be employed, at no additional reimbursement.

D. Core Drilled Holes: At core drilled holes, the specified sleeves will generally be required, unless otherwise indicated. Where omission of a sleeve is approved, the hole shall be drilled approximately one inch larger than the outside diameter of the insulation, where insulated. When the pipe is installed, hold down centering wedges one inch minimum below the floor line. The opening shall be sealed.

END OF SECTION

SECTION 017329
CUTTING AND PATCHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cutting, demolition, removal work, patching and restoration of work as necessary to accomplish and complete all work under the Contract, including any relocation or reuse of existing materials, equipment, systems, or other work, as well as the disposition of salvaged materials or debris.
   2. This Section applies to all work under the Contract, including general construction, mechanical and electrical work.

B. Related Sections:
   1. Refer to Sections 01100 and 01500 for special requirements, protection, constraints, timing of work, scheduling of work, enclosures and similar requirements relating to this Section.
   2. Section 024119 – Selective Demolition.

1.2 DESCRIPTION

A. Drawings generally indicate the extent of demolition, removals, relocations and cutting. The drawings shall not be construed as indicating all required work, nor indicating all conditions or details which might be encountered to accomplish the work of this Contract.
   1. The Contractor and subcontractors must examine the spaces themselves to determine the actual conditions and requirements. All removals, demolition, cutting, restoration, new installations and other work shall be accomplished to transform the existing spaces and conditions to the new conditions required under the Contract, as well as to accomplish all tie-in work of new to existing.

B. It is the intent that unless specifically shown on the general construction type drawings (i.e., architectural and structural) and schedules, or is inherent in the work to be accomplished under the general construction work of the area, that the mechanical and electrical subcontractors shall perform the demolition, cutting, removals, relocations, patching and restoration as will be required to accomplish the work under their subcontracts.
   1. All work shown or indicated on the general construction drawings and schedules shall be accomplished by the General Contractor.

C. Except for general demolition of entire areas it is the intent that at each area, or space, the Contractor and each subcontractor must make the removals, perform cutting or demolition and accomplish relocations of work normal to their trades (i.e., Mechanical Subcontractor removes or relocates piping, ductwork and similar; Electrical Subcontractor removes or relocates panelboards, conduit, lighting and similar).
   1. At areas of general demolition of the entire spaces, the Mechanical and Electrical shall make removals or work normal to their trades or may be called for, for reuse or relocation, make any relocations and cut-off, terminate, cap or otherwise discontinue services that will be abandoned or removed in the space. The General Contractor must then demolish or remove all abandoned or unwanted electrical or mechanical materials, items or elements in the area.

1.3 SUBMITTALS

A. Schedule: Submit schedule indicating proposed sequence of operations for demolition work to Owner's Representative for review prior to start of work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.
   1. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.

2. Coordinate with Owner's continuing occupation of portions of existing building and with Owner's partial occupancy of completed new addition.

1.4 QUALITY ASSURANCE

A. Skilled Mechanics: Accomplish all work of cutting, removal, demolition, relocation, patching and other restoration by using only mechanics skilled in the trade. If necessary, sublet the work to skilled contractors or subcontractors.

B. Safety: The Contractor is fully responsible for the safety of the existing buildings and personnel, as well as new construction as a result of work, procedures, operations or activities of this Contract.

C. Structural Work: Where the work of removals, demolition, cutting and similar work involves structural consideration, extreme care shall be exercised to avoid damage and preserve the safety of the structure and all personnel.

1. Particular care must be taken where the demolition or removals occur adjacent to occupied areas. Utilize (employing if necessary) competent and qualified technical assistance to develop safe methods and techniques to accomplish the work, including for temporary shoring and supports, methods of removal and other considerations.
2. All permanent or temporary supports shall be so designed and placed by considering all loads and shall be carried down to sound bearing.

D. Hazardous Substances: Where the work of removals, demolition, cutting and similar work involves possible hazardous substances and/or harmful physical agents, such as asbestos fibers, or polychlorinated biphenyl (PCB), extreme care shall be exercised to avoid damage and preserve the safety of all personnel. Contractor must stop the work and notify the Owner and Architect, in accordance with provisions of AIA General Conditions Article 10.1.

E. Remove resilient sheet vinyl and tile and cutback asphaltic adhesives in accordance with Resilient Floor Covering Institute (RFCI) "Recommended Work Practices for the Removal of Resilient Floor Coverings", July 1990.

1.5 COORDINATION

A. Coordination: Coordinate all work of this Section with all subcontractors so the work will progress without interruption and minimum delays. The Contractor must also coordinate and schedule the work with the Owner where possible disturbance may occur and where relocations or other potential disruptions of the Owner's functions and services may occur. All work affecting the Owner's functions and services shall be performed at times acceptable to the Owner.

PART 2 DISPOSITION OF MATERIALS

2.1 UNSALVABLE MATERIALS

A. Remove unsalvable materials in a manner that will avoid damage to materials or equipment which will remain. Completely remove and legally dispose away from the site.

2.2 SALVABLE MATERIALS TO BE RE-USED IN THE WORK

A. Salvable materials and items designated for reuse or relocation shall be removed by the applicable trades and relocated to the new location. If the new location is not ready to receive the relocated item, it shall be stored and protected from damage until incorporated into the new work or remodeled area. If the Owner is unable to forego the use of any existing items at the normal time for relocation until other facilities are available to the Owner, make all preparations for the item and delay relocation until a time approved by the Owner.

B. Carefully remove, salvage, clean and preserve materials, equipment and other items indicated to be reused, or which will be needed for reuse to match existing work. Exercise extreme care in removals to prevent damage or to make materials unsuitable to reuse. For materials shown or called for to be reused and which are damaged, replace with equivalent and matching work.

C. Where brick from existing building is required for patching, exercise care in removing brick from existing building to preserve for reuse. Do not reuse broken brick. After removal clean all mortar from all sides of brick, carefully stockpile and protect to insure brick is available for reuse. Stockpile off site, if space is not available at site, and cover or otherwise protect from soil or damage. Stockpile on suitable platform (not on earth).

2.3 SALVABLE MATERIALS TO BE STORED BY THE OWNER

A. The Owner will mark or tag existing materials, equipment or other items Owner wishes to retain. Salvable materials and items designated or marked to remain the property of the Owner shall be carefully removed by the applicable trades, protected from damage and stored adjacent to the removal area as directed.

B. Consult the Owner for any salvage the Owner may wish to retain and the salvageability of all items. Carefully remove and salvage any materials the Owner wishes to retain. Remove finish hardware from the item or material taken out of the building and turn over to Owner. Cleaning or restoration of the Owner's salvage materials is not required.

C. Removal from the area and the site to the Owner's storage will be by the Owner.

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

B. After uncovering, inspect conditions affecting performance of work.

C. Beginning of cutting or patching means acceptance of existing conditions.

3.2 TEMPORARY PROTECTION

A. Provide temporary bracing, shoring, needling and support during demolition, cutting, remodeling and related new construction as necessary for the execution of the Work and the protection of persons and property. Perform all work with appropriate supports, protection and methods to prevent collapse, settling or damage to property or persons. Provide adequate supports for the loads to be carried, with loads properly distributed, including to lower levels and sound bearing, if necessary.

B. Provide protective coverings and enclosures necessary to prevent damage to existing spaces and materials to remain. Protect openings in exterior walls and roofs so as to prevent damage from water and the elements and prevent excessive heat loss from the existing buildings. Coordinate work and removals at exterior, including roof, by scheduling and performing to maintain watertight installation. Seal areas left temporarily unfinished to prevent damage to existing roof or other materials and furnishings of existing building.

C. Provide dustproof temporary enclosures (including above ceilings) separating areas under demolition and remodeling from the remainder of the building as well as temporary filters at duct work. Provide temporary hinged doors in temporary enclosures where necessary. Temporary and permanent doors shall be completely sealed with tape or other suitable material during demolition work and shall remain sealed until dust has settled.

D. Provide protection from elements for that portion of the Project which may be exposed by cutting and patching work, and maintain excavations free from water.

3.3 DEMOLITION AND CUTTING

A. Demolish and remove existing construction as shown, indicated or required to be removed to accomplish the Work. Where new Work is to be installed in or adjacent to existing construction or existing work is to be replaced, remove or cut the existing construction as necessary to complete the Work of the Project.

B. Execute work with care. Existing construction that is to remain which is loosened, cracked, or otherwise damaged or defaced as a result of the Work and is unsuitable for use intended shall be removed and replaced at no additional cost to the Owner.

C. Debris from upper levels shall be transported to ground in covered chute or other approved means. No free-fall debris removal is permitted. Moisten debris with spray where practical. Take all precautions to minimize dust.

D. Clean demolition areas and remove debris, waste and rubbish from the building at the conclusion of each day's work. Transport debris and rubbish in such a manner so as to prevent spread of dust. Do not store or permit debris storage at site. Do not burn debris, rubbish or waste at the site. Keep adjacent areas unencumbered and clean. Keep walks and similar areas broom clean.

3.4 PATCHING, REMODELING, REPLACEMENTS AND RESTORATION

A. Patch or otherwise restore disturbed existing construction as indicated on the drawings and schedules, or as otherwise required to restore the work and surfaces. Patching or restoration shall be carried to natural breaks (i.e., corners) wherever possible. Where existing construction is removed, cut or otherwise disturbed by Work of the Project, patch defective and incomplete surfaces. Repair any damage to existing construction which is to remain.

B. Patching work shall be done by skilled mechanics experienced in the particular type of work involved. Patching work shall conform to the standards of the Specifications where applicable and where not specified, work shall conform to the highest standards of the trade.

C. Patch existing construction to match existing work (unless otherwise called for) except provide new materials and accomplish as for new work. Examine existing surfaces to be patched before proceeding with the work. Report all conditions where existing materials, colors and finishes cannot be matched to the Architect and Owner, and do not proceed until instructions have been given.

D. Existing construction that has been damaged as a result of the Work shall be repaired to an extent and as required to match adjacent existing undamaged construction.

E. Thoroughly clean and prepare all surfaces to receive new finish or covering. Completely remove dirt, dust, grease, oil, paint, loose materials and soil. Clean, etch where necessary, and place surfaces in most suitable condition for the finish.

3.5 ADJUSTMENTS

A. Where partitions are removed, patch floors, walls, and ceilings, with finish materials to match existing.

1. Where removal of partitions results in adjacent spaces becoming one, rework floors and ceilings to provide smooth planes without breaks, steps, or bulkheads.
2. Where extreme change of plane of two inches or more occurs, request instructions from Architect as to method of making transition.

B. Trim and refinish existing doors as necessary to clear new floors.

3.6 MECHANICAL AND ELECTRICAL WORK EXPOSED

A. Where unknown mechanical piping, ductwork or electrical conduit is exposed during removal of partitions, walls or floors and ceilings, the removal or rerouting shall be accomplished by the Mechanical or Electrical Subcontractor as applicable. Locate mechanical and electrical work where directed and connect to maintain all functions in proper operation. Abandoned piping may be left in place where it is concealed in floors or walls, providing that it is disconnected from its source and capped. There shall be no "dead end" water, sewer, gas, or vent piping existing in the completed work.

B. Accomplish removals, capping or otherwise terminating services which are abandoned or need to be abandoned, and rerouting of mechanical and electrical work without additional cost to the Owner, whether shown or noted on drawings or otherwise encountered.

3.7 WORK AT EXISTING ROOF

A. Verify with the Owner to ascertain the existence of an existing roof bond or guarantee. Cutting and patching of existing building roof shall be performed with compatible materials using methods so as not to invalidate any current bond or guarantee. Cutting of all openings through roof shall be done by manufacturer's licensed or approved roofing contractor. Arrange with the manufacturer who furnished the roof bond or with the roofer who provided the roof guarantee for an examination of the complete work and provide two copies of an acknowledgement and/or approval to the Owner indicating that such bond or guarantee (if any) will remain in effect.

B. Spud off gravel about 4 feet back from roof penetration at areas indicated on roof plan and/or details at existing roof construction. Remove and patch materials to extent indicated. Feather roofing plies back, down to existing insulation; remove cut or damaged insulation and provide new insulation where required. New felts shall overlap each other and stagger back onto existing roof at successive plies. Provide at least four (4) plies. Flood coat new roof membranes and regravel where required.

C. At existing membrane roof system, cut and patch membrane and insulation as required at penetrations. Remove and patch materials to extent indicated. Remove cut or damaged insulation and provide new insulation where required. Regravel where required.

3.8 WORK OF EACH CONTRACT

A. The Contractor and each subcontractor must carefully review the Contract Documents including those primarily for other trades with respect to the coordination of the demolition, removal and remodeling work and perform such removals normal to their trades as may be shown, noted or otherwise required. Cutting and patching incidental to demolition, removal and/or remodeling of general construction work shall be construed as the work of the General Contractor when shown or indicated on the general construction drawings or schedules or specifically noted or called for on documents primarily for other trades as being accomplished by the General Contractor. Other subcontractors (mechanical or electrical) are responsible for such other cutting, demolition, patching, replacement and restoration as may be required to accomplish their part of the Work.

3.9 PAINTING

A. Each major subcontractor (mechanical, electrical) shall be responsible for painting or repainting of patched or remodeled areas where they have performed work, except for those areas shown or required to be remodeled under the general construction drawings, specifications or schedules, in which case, the new, patched and remodeled paintable surfaces shall be repainted by the General Contractor. It is the intent that the mechanical and electrical subcontractors are responsible to paint or repaint surfaces at locations where demolition, cutting and patching has been accomplished only for their work.

B. Painting, including preparation, materials, workmanship and number of coats shall comply with Section 099000 - Painting. Painting of surfaces patched shall extend to natural breaks, such as corners, as approved by the Architect and Owner.

3.10 FLOOR PREPARATION (EXISTING SLABS)

A. Prepare existing concrete slabs for the installation of various floor finish materials, i.e., VCT, ceramic and quarry tile, carpet (glue-down), concrete topping.

B. Roughen surfaces which are glossy or which have loose surface material or curing sealers by sanding, scarifying or acid etching as required. Remove surface material that is not compatible with adhesive. Clean thoroughly to remove all oil, dirt, sealer materials and dust.

3.11 CLEANING

A. Perform periodic and final cleaning as specified in Section 017700 - Closeout Procedures.
   1. Clean Owner-occupied areas daily.
   2. Clean spillage, overspray, and heavy collection of dust in Owner- occupied areas immediately.

B. At completion of work of each trade, clean area and make surfaces ready for work of successive trades.

C. At completion of alterations work in each area, provide final cleaning and return space to a condition suitable for use by Owner.

END OF SECTION

APPENDIX A
SPECIAL FEDERAL DOCUMENTS

PART 1 GENERAL

1.1 SUMMARY

A. See the following attached Special Federal Documents:

END OF SECTION

COMMITMENT TO SUBCONTRACT TO DBE NON-TRADITIONAL PROJECTS

Wisconsin Department of Transportation

DT1880 4/2010 s.84.06(2) Wis. Stats.

Project(s): 1693-35-72
CNG Fueling Station 3025 W. Ruby Ave.
City of Milwaukee

Prime Contractor: _____

County: Milwaukee

Letting Date: February 2, 2015

This contract requires that a specified percentage of the work be subcontracted to a disadvantaged business enterprise and that this information be submitted within **10 business days** after the notification of contract award. Completion of the following information indicates your intent in the fulfillment of these contract requirements.

Total $ Value of: _____

Prime Contract: _____

DBE Contract Goal: 15 %

This form must be completed and returned for THIS contract. See reverse side for instructions.

A	V	NAME OF DBE SUBCONTRACTOR	TYPE OF WORK	SUBCONTRACT $ VALUE	Government Use Only Adjusted Amounts
		SUBTOTAL DBE $ VALUE	**A ($)**	**TOTAL %**	
			V ($)	**TOTAL %**	

A	V	NAME OF DBE SUPPLIER AND/OR MANUFACTURER (see #3 on Instructions)	TYPE OF MATERIAL	SUBCONTRACT $ VALUE	Government Use Only Adjusted Amounts
		SUBTOTAL DBE $ VALUE	**A ($)**	**TOTAL %**	
			V ($)	**TOTAL %**	

A	V	NAME OF DBE TRUCKING FIRM	MATERIAL HAULED	EST. # OF TON/C.Y.	EST. # OF TRUCKS REQ'D		$ VALUE	Government Use Only Adjusted Amounts
					O=	L=		
					O=	L=		
					O=	L=		
					O=	L=		
					O=	L=		
		SUBTOTAL DBE $ VALUE	**A ($)**		**TOTAL %**			
			V ($)		**TOTAL %**			
		GRAND TOTAL DBE $ VALUE	**A ($)**		**TOTAL %**			
			V ($)		**TOTAL %**			
			T =		**TOTAL %**			

I certify that arrangements have been made for the foregoing work with the listed DBE Contractors. I further understand that any willful falsification, fraudulent statement or misrepresentation will result in appropriate sanctions, which may include debarment and/or prosecution under applicable State (Trans 504) and Federal laws.

O = Owned Trucks Used on Project

L = Leased Trucks Used on Project

A = Assigned (DBE Conscious)

V = Voluntary

Government Use Only Approved Amounts

A = $ %

V = $ %

Total = $ %

Signature:

X

(Authorized Agent)

(Date)

Mail to: Wisconsin Department of Transportation
DBE Programs Office, Rm. 451

(DBE Neutral)	Date: Good faith waiver granted: Yes ☐ No ☐	PO Box 7965 Madison, WI 53707-7965

Proposal Number _____

Instructions For Completing Commitment To Subcontract To DBE Form:

1 In accordance with the DBE Regulations (49 CFR part 26), WisDOT is tracking Assigned Goals for DBE's (DBE Conscious) and Voluntary Usage of DBE Firms (DBE Neutral). DBE participation reported on this form will be used to periodically adjust (DBE Conscious and DBE Neutral) components of WisDOT's overall annual DBE goal.

2 For each DBE firm listed on this form, place an "x" in the appropriate column to indicate whether it will be used to meet the Assigned Goal (A) and/or whether it is used on a Voluntary basis (V). Any achievement above assigned goals should be reported as a voluntary achievement. If you indicate that a firm will be used to meet both assigned and voluntary goals, indicate the dollar amount attributable to assigned goals and the amount attributable to the voluntary goal. Our objective is to capture all DBE achievement you generate. The following is an example:

a. The total contract amount is $100,000 and the DBE goal is 10% or $10,000 in DBE participation
b. If $10,000 is the subcontract dollar value to ADBE Landscaping Co. then $10,000 would be Assigned (DBE Conscious) and you would place an "x" in the "A" column
c. If $15,000 is the subcontract dollar value to ADBE Landscaping Co. then $10,000 would be Assigned (DBE Conscious) and you would place an "x" in the "A" column and ADBE Landscaping Co. would be listed **on the next line** for $5,000 which would be Voluntary (DBE Neutral) and an "x" would be placed in the "V" column

3 The department will give full credit toward the DBE goal if the DBE is a manufacturer of their materials or supplies. The department will give 60 percent credit or brokerage fee set by industry's standard toward the DBE goal if the DBE is merely a supplier of these materials or supplies. It is the Prime Contractor's responsibility to use the Bidder's List or UCP Directory to find out if the DBE is considered a supplier or a manufacturer before listing them on Commitment to Subcontract to DBE form. WisDOT will apply the appropriate credit when approving the form.

4 After completing the form, if it does not indicate that the DBE goal has been met or exceeded, please complete and supply the necessary documentation on the Certificate of Good Faith Efforts form (DT1202 6/2007.)

Instructions For Completing Attachment A Form:

5 Section 26.53 (49 CFR part 26) requires written confirmation of participation from each DBE firm to be used on the contract. Please submit one copy of a completed Attachment A, Confirmation of Participation form, for each DBE firm to be used on this contract. Each form must be signed by the Prime Contractor, the hiring contractor (if applicable) and the DBE Firm specified on the form.

6 DBE crediting for the trucking industry is achieved in the following manner:

a. A minimum of one truck owned by the DBE must be used on the contract.
b. Full DBE credit is given for owned trucks and trucks leased from another DBE.
c. For one truck owned by the DBE firm, they can receive DBE credit for a truck leased from a non-DBE firm (one DBE truck owned = one non-DBE truck leased).
d. Trucks leased from non-DBE firms above the one-for-one ratio described in letter c, will be given DBE credit only for the brokerage fee charged by the DBE.
e. All trucks used for credit must be listed and approved on the DBE firm's Schedule of Owned/Leased Vehicles for DBE Credit and/or a WisDOT approved trucking utilization plan.

It is the Prime Contractor's and the DBE firm's responsibility to ensure that utilization of trucks and the DBE credit earned is in accordance with the above and will yield the subcontract dollar value listed on the Commitment to Subcontract to DBE form.

If you have questions about filling out these forms, please contact the Civil Rights and Compliance Office at (608) 266-6961.

COMMITMENT TO SUBCONTRACT TO DBE
ATTACHMENT A

CONFIRMATION OF PARTICIPATION

Project I.D.: 1693-35-72	Proposal Number:
Letting Date: February 2, 2015	Total $ Value of Prime Contract:

Name of DBE Firm Participating in this Contract:
Name of the Prime/Subcontractor who hired the DBE Firm: *(list all names of tiers if more than one)*
Type of Work or Type of Material Supplied:
Total Subcontract Value:

FOR PRIME CONTRACTORS ONLY: I certify that I made arrangements with the participating DBE firm to perform the type of work listed or supply the material indicated above for the subcontract value listed above.	Prime Contractor Representative's Signature
	Prime Contractor Representative's Name (Print Name)
	Prime Contractor (Print Company Name)
	Date

FOR PARTICIPATING DBE FIRMS ONLY: I certify that I made arrangements with the Prime Contractor or the Hiring Contractor to perform the type of work or supply the material indicated above for the subcontract value listed above. **FOR DBE TRUCKING FIRMS ONLY:** I certify that I will utilize, for DBE credit, only trucks listed on my WisDOT approved Schedule of Owned/Leased Vehicles for DBE Credit form and I will be utilizing the number of trucks and material hauled as listed below.	Participating DBE Firm Representative's Signature
	Participating DBE Firm Representative's Name (Print Name)
	Participating DBE Firm (Print Company Name)
	Date

# Owned Trucks	# Leased Trucks	# Estimated Tons/C.Y.	Material(s) Hauled

APRIL 2013

ADDITIONAL FEDERAL-AID PROVISIONS

NOTICE TO ALL BIDDERS

To report bid rigging activities call:

1-800-424-9071

The U.S. Department of Transportation (DOT) operates the above toll-free "hotline" Monday through Friday, 8:00 a.m. to 5:00 p.m., Eastern Time. Anyone with knowledge of possible bid rigging, bidding collusion, or other fraudulent activities should use the "hotline" to report such activities.

The "hotline" is part of the DOT's continuing effort to identify and investigate highway construction contract fraud and abuse and is operated under the direction of the DOT Inspector General. All information will be treated confidentially and caller anonymity will be respected.

SEPTEMBER 2002

NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY (EXECUTIVE ORDER 11246)

1. The Offeror's or Bidder's attention is called to the "Employment Practices" and "Equal Opportunity Clause" set forth in the Required Contract Provisions, FHWA 1273.

2. The goals and timetables for minority and female participation expressed in percentage terms for the contractor's aggregate work force in each trade, on all construction work in the covered area, are as follows:

Goals for Minority Participation for Each Trade:

County	%	County	%	County	%
Adams	1.7	Iowa	1.7	Polk	2.2
Ashland	1.2	Iron	1.2	Portage	0.6
Barron	0.6	Jackson	0.6	Price	0.6
Bayfield	1.2	Jefferson	7.0	Racine	8.4
Brown	1.3	Juneau	0.6	Richland	1.7
Buffalo	0.6	Kenosha	3.0	Rock	3.1
Burnett	2.2	Kewaunee	1.0	Rusk	0.6
Calumet	0.9	La Crosse	0.9	St. Croix	2.9
Chippewa	0.5	Lafayette	0.5	Sauk	1.7
Clark	0.6	Langlade	0.6	Sawyer	0.6
Columbia	1.7	Lincoln	0.6	Shawano	1.0
Crawford	0.5	Manitowoc	1.0	Sheboygan	7.0
Dane	2.2	Marathon	0.6	Taylor	0.6
Dodge	7.0	Marinette	1.0	Trempealeau	0.6
Door	1.0	Marquette	1.7	Vernon	0.6
Douglas	1.0	Menominee	1.0	Vilas	0.6
Dunn	0.6	Milwaukee	8.0	Walworth	7.0
Eau Claire	0.5	Monroe	0.6	Washburn	0.6
Florence	1.0	Oconto	1.0	Washington	8.0
Fond du Lac	1.0	Oneida	0.6	Waukesha	8.0
Forest	1.0	Outagamie	0.9	Waupaca	1.0
Grant	0.5	Ozaukee	8.0	Waushara	1.0
Green	1.7	Pepin	0.6	Winnebago	0.9
Green Lake	1.0	Pierce	2.2	Wood	0.6

Goals for female participation for each trade: 6.9%

These goals are applicable to all the contractor's construction work, (whether or not it is federal or federally assisted), performed in the covered area. If the contractor performs construction work in the geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the contractor also is subject to the goals for both its federally involved and nonfederally involved construction.

The contractor's compliance with the Executive Order and the Regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from contractor to contractor or from project to project for the sole purpose of meeting the contractor's goals shall be a violation of the contract, the Executive Order and the Regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within ten (10) working days of award of any construction subcontract in excess of $10,000.00 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number of the subcontractor, employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

   As referred to in this section, the Director means:

   Director
   Office of Federal Contract Compliance Programs
   Ruess Federal Plaza
   310 W. Wisconsin Ave., Suite 1115
   Milwaukee, WI 53202

   The "Employer Identification Number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.

4. As used in this notice, and in the contract resulting from solicitation, the "covered area" is the county(ies) in Wisconsin to which this proposal applies.

ADDITIONAL SPECIAL PROVISION 3
DISADVANTAGED BUSINESS ENTERPRISE PROGRAM

1. Description

General

a. The disadvantaged business enterprise (DBE) requirements of 49 CFR Part 26 apply to this contract. The department's DBE goal is shown on the cover of the bidding proposal. The contractor can meet the specified contract DBE goal by procuring services or materials from a DBE or by subcontracting work to a DBE. The department calculates the DBE participation as the dollar value of DBE participation included in the bid expressed as a percentage of the total contract bid amount.

b. Under the contract, the contractor agrees to provide the assistance to participating DBE's in the following areas:

   i. Produce accurate and complete quotes.
   ii. Understand highway plans applicable to their work.
   iii. Understand specifications and contract requirements applicable to their work.
   iv. Understand contracting reporting requirements.

c. The department encourages the contractor to assist and develop DBE firms to become fully knowledgeable contractors to successfully perform on its contracts.

d. For information on the disadvantaged business program, visit the department's Civil Rights and Compliance Section website at:

   http://www.dot.wisconsin.gov/business/engrserv/dbe-main.htm

2. Definitions

a. Interpret these terms, used throughout this additional special provision, as follows:

   i. **Bid Percentage:** The DBE percentage indicated in the bidding proposal at the time of bid.
   ii. **DBE:** A disadvantaged business enterprise (DBE) certified as a DBE by the department and included on the department's list of certified DBE's who are determined to be ready, willing and able.
   iii. **DBE goal:** The amount of DBE participation expected in the contract as shown on the cover of the Highway Work Proposal.
   iv. **Discretionary Goal:** A contractor assigned DBE goal, typically abbreviated as “Disc” on the cover of the Highway Work Proposal, which is enforced as committed.
   v. **Manufacturer:** A firm that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract.
   vi. **Supplier:** A firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment required under the contract are bought, kept in stock, and regularly sold or leased to the public.
   vii. **Voluntary Achievement:** The amount of DBE participation achieved and reported in the contract in excess of the assigned goal.

3. DBE Percentage Required at Bid Submission

Indicate the bid percentage (i.e. 0% through 100%) of DBE participation on the completed bidding proposal, including projects with discretionary goals. For electronic submittals, show the percentage in the miscellaneous data folder, Item 3, DBE Percent. For paper submittals, show the percentage on the sheet included after the schedule of items. By submission of the bid, the bidder contractually commits to DBE participation at or above the bid percentage, or certifies that they have utilized

comprehensive good faith efforts to solicit and utilize DBE firms to meet the DBE participation requirements of this contract proposal, and that the bid percentage is reflective of these good faith efforts. If the bidder does not indicate the bid percentage of DBE participation on the completed bidding proposal, the department will consider the bid irregular and may reject the bid.

4. Department's DBE Evaluation Process

a. Documentation Submittal

Within 10 business days after the notification of contract award, the contractor is to identify, by name, the DBE firms whose utilization is intended to satisfy this provision, the items of work of the DBE subcontract or supply agreement and the dollar value of those items of work by completing the Commitment to Subcontract to DBE Form [DT1506] and all necessary attachment A forms, as well as, Good Faith Waiver Form [DT1202] and supporting documentation as necessary. If the contractor fails to furnish the required forms within the specified time, the department may cancel the award. Delay in fulfilling this requirement is not a cause for extension of the contract time and shall not be used as a tool to delay execution.

i. Bidder Meets DBE Goal

If the bidder indicates that the contract DBE goal is met, after award and before execution, the department will evaluate the Commitment to Subcontract to DBE Form DT1506 and attachment A(s) to verify the actual DBE percentage achieved. If the DBE commitment is verified, the contract is eligible for execution with respect to the DBE commitment.

ii. Bidder Does Not Meet DBE Goal

(1) If the bidder indicates a bid percentage on the Commitment to Subcontract to DBE Form [DT1506] that does not meet the contract DBE goal, the bidder must submit a Good Faith Waiver Form [DT1202] and supporting documentation. After award and before execution, the department will evaluate the bidder's DBE commitment and consider the bidder's good faith waiver request.

(2) The department will review the bidder's good faith waiver request and notify the bidder of one of the following:

a. If the department grants a good faith waiver, the bid is eligible for contract execution with respect to DBE commitment.

b. If the department rejects the good faith waiver request, the department may declare the bid ineligible for execution. The department will provide a written explanation of why the good faith waiver request was rejected. The bidder may appeal the department's rejection as allowed under 7 a. & b.

5. Department's Criteria for Good Faith Effort

The Code of Federal Regulations {CFR}, 49 CFR Part 26-Appendix A, is the guiding regulation concerning good faith efforts. However, the federal regulations do not define “good faith” but states that bidder must actively and aggressively attempt to meet the goal. The federal regulations are general and do not include every factor or effort that can be considered. As a result, each state must establish its own processes and consider the factors established in its own process when making a determination of good faith.

a. The department will only grant a good faith waiver if the bidder has made the effort, given the relevant circumstances under the contract that a bidder actively and aggressively seeking to meet the goal would make. The department will evaluate the bidder's good faith effort to determine whether a good faith waiver will be granted. The bidder must demonstrate, on the DT1202 that they have aggressively solicited DBE participation in an attempt to meet the contract DBE goal and attaining the stated DBE goal is not feasible.

b. The department, in conjunction with industry stakeholders, has developed the following guidance for contractor good faith effort. The guidance and the attached appendices provide a framework for the actions required by all parties in the processing and evaluation of bidder's total efforts to achieve the project specific DBE goal prior to the bid letting date.

c. Prime Contractors should:

i. Document all efforts and decisions made toward achieving the DBE goal on the contract. The bidder should use the Civil Rights & Compliance System [CRCS] and related WisDOT-approved DBE outreach tools, including the Bid Express Small Business Network, to foster DBE participation on all applicable contracts.

ii. Request quotes by identifying potential items to subcontract and solicit. Prime contractors are strongly encouraged to include in their initial contacts a single page including a detailed list of items for which they are accepting quotes, by project, within a letting. *See attached sample entitled "Sample Contractor Solicitation Letter" in Appendix A*. Prime contractors should also indicate a willingness to accept quotes in areas they are planning to perform themselves, ***as required by federal rules***. In some cases, it might be appropriate to use DBE's to do work in a prime contractor's area of specialization.

(1) Solicit quotes through all reasonable and available means from certified DBE firms who match 'possible items to subcontract' and send copies to DBESS office, highlighting areas in which you are seeking quotes. Email is acceptable.

(2) SBN is the preferred outreach tool. https://www.bidx.com/wi/main. Other acceptable means include postal mail, email, fax, phone call.

a. Primes must ask DBE firms for a response in their solicitations. See *Sample Contractors Solicitation Letter* in Appendix. This letter can be included as an attachment to the SBN sub-quote request.

b. Solicit quotes at least 10 calendar days prior to the letting date {ideally two Fridays before the letting} to allow DBE firms sufficient time to respond. Prime contractors should contact DBE firms early, asking them if they need help in putting together a quote, or helping to arrange for equipment needs, or solve other problems.

(3) Second solicitation should take place within 5 days

a. An email solicitation is highly recommended for this second solicitation

(4) Upon request, provide interested DBE firms with adequate information about plans, specifications and the requirements of the contract by letter, information session, email, phone call and/or referral.

(5) When potential exists, advise interested DBE firms on how to obtain bonding, line of credit or insurance as may be requested.

(6) Document DBE firm's interest in quoting by taking appropriate steps to follow up initial solicitation with:

a. Email to all prospective DBE firms in relevant work areas
b. Phone call log to DBE firms who express interest via written response or call.
c. Fax/letter confirmation
d. Copy of the DBE quotes
e. Signed copy of Bid Express SBN Record of Subcontractor Outreach Effort.

d. Evaluate DBE quotes as documentation is critical if the prime does not utilize the DBE firm's quote for any reason.

i. Evaluate DBE firm's capability to perform 'possible items to subcontract' using legitimate reasons, including but not limited to, ***a discussion with the DBE firm*** regarding its

capabilities prior to the bid letting. If lack of capacity is your reason for not utilizing the DBE quote, you are required to contact the DBE directly regarding their ability to perform the work indicated in the UCP directory as their work area [NAICS code]; only the work area and/or NAICS code listed in the UCP directory will be counted for DBE credit. Documentation of the conversation is required.

ii. In striving to meet a DBE conscious contract goal, prime contractors are expected to use DBE quotes that are responsive and reasonable. This includes DBE quotes that are not the low quote.

iii. **Special Circumstance:** Evaluation of DBE quotes with tied bid items. "Tied quotes are the condition in which a subcontractor submits quotes including multiple areas of expertise across multiple work areas noting that the items and price are tied. Typically this type of quoting represents a cost saving to the prime but is not clearly stated as a discount; tied quotes are usually presented as 'all or none' quote to the prime." When non-DBE subcontractors submit tied bid items in their quotes to the prime, the DBE firms' quote may seem not competitive. In such a case, the following steps are taken in comparing the relevant quotes. These are qualitative examples.

(1) Compare bid items common to both quotes, noting the reasonableness in the price comparison.

(2) Review quotes from other firms for the bid items not quoted by the DBE firm to see if combining both can provide the same competitive advantage that the tied bid items offered.

e. After notification of contract award, submit **'Commitment to Subcontract'** form within the time period specified in the contract.

i. Provide the following information along with department form DT1202:

(1) The names, addresses, e-mail addresses, telephone numbers of DBE's contacted. The dates of both initial and follow-up contact. A printed copy of SBN solicitation is acceptable.

(2) A description of information provided to the DBE's regarding the plans, specifications, and estimated quantities for portions of the work to be performed by that DBE.

(3) Photocopies or electronic copies of all written solicitations to DBE's.

(4) Documentation of each quote received from a DBE and, if rejected, the reason for that rejection.

(5) Bidder attendance at any pre-solicitation or pre-bid meetings the department held to inform DBE's of participation opportunities available on the project.

f. The department's DBE Support Services Office is available by phone, email or in writing to request assistance in meeting the DBE goal:

DBE Support Services Office
6150 Fond du Lac Ave.
Milwaukee, WI 53218
Phone: 414-438-4583 / 608-266-6961
Fax: 414-438-5392
E-mail: DOTDBESupportServices@dot.wi.gov

6. Bidder's Appeal Process

a. A bidder can appeal the department's decision to deny the bidder's good faith waiver request. The bidder must provide written documentation refuting the specific reasons for rejection as stated in the department's rejection notice. The bidder may meet in person with the department if so

requested. Failure to appeal within 7 calendar days after receiving the department's written notice of rejection of a good faith waiver request under constitutes a forfeiture of the bidder's right of appeal. If the bidder does not appeal, the department may declare the bid ineligible for execution.

b. The department will appoint a representative, who did not participate in the original determination, to assess the bidder's appeal. The department will issue a written decision within 7 calendar days after the bidder presents all written and oral testimony. In that written decision, the department will explain the basis for finding that the bidder did or did not meet the contract DBE goal or make an adequate good faith effort to meet the contract DBE goal. The department's decision is final. If the department finds that the bidder did not meet the contract DBE goal or did not make adequate efforts to meet the DBE goal, the department may declare the bid ineligible for execution.

7. Department's Criteria for DBE Participation

Department's DBE List

a. The department maintains a DBE list on the department's website at

http://app.mylcm.com/wisdot/Reports/WisDotUCPDirectory.aspx

b. The DBE office is also available to assist at 414-438-4583 or 608-266-6961.

8. Counting DBE Participation

Assessing DBE Work

a. The department will only count the DBE usage towards the contract DBE goal if the DBE firm is certified as a DBE by one of the unified certification program agencies. If a firm becomes DBE certified before entering into a subcontract, the department may consider that DBE usage towards the contract goal. The department only counts the value of the work a DBE actually performs towards the DBE goal. The department assesses the DBE work as follows:

b. The department counts work performed by the DBE's own resources. The department includes the cost of materials and supplies the DBE obtains for the work. The department also includes the cost of equipment the DBE leases for the work. The department will not include the cost of materials, supplies, or equipment the DBE purchases or leases from the prime contractor or its affiliate, except the department will count non-project specific leases the DBE has in place before the work is advertised.

c. The department counts fees and commissions the DBE charges for providing a bona fide professional, technical, consultant, or managerial services. The department also counts fees and commissions the DBE charges for providing bonds or insurance. The department will only count costs the engineer deems reasonable based on experience or prevailing market rates.

d. If a DBE subcontracts work, the department counts the value of the subcontracted work only if the DBE's subcontractor is also a DBE.

e. The contractor shall maintain records and may be required to furnish periodic reports documenting its performance under this item.

f. It is the prime contractor’s responsibility to determine the DBE's ability to perform the work with the use of the UCP directory.

9. Commercially Useful Function

a. The department counts expenditures of a DBE toward the DBE goal only if the DBE is performing a commercially useful function on that contract.

b. A DBE is performing a commercially useful function if the following conditions are met:

c. For contract work, the DBE is responsible for executing a distinct portion of the contract work and it is carrying out its responsibilities by actually performing, managing, and supervising that work.

d. For materials and supplies, the DBE is responsible for negotiating price, determining quality and quantity, ordering, and paying for those materials and supplies.

10. Trucking

All bidders are expected to adhere to the department's current trucking policy posted on the HCCI website at

http://www.dot.wisconsin.gov/business/engrserv/docs/dbe-trucking-notice.pdf

11. Manufacturers and Suppliers

The department counts material and supplies a DBE provides under the contract. The department will give full credit toward the DBE goal if the DBE is a manufacturer of those materials or supplies. The department will give 60 percent credit toward the DBE goal if the DBE is merely a supplier of those materials or supplies. It is the bidder's responsibility to find out if the DBE is considered a supplier or a manufacturer before listing them on Commitment to Subcontract to DBE form DT1506.

12. DBE Prime

If the prime contractor is a DBE, the department will only count the work the contractor performs with its own forces, the work DBE subcontractors perform, and the work DBE suppliers or manufacturers perform.

13. Joint Venture

If a DBE performs as a participant in a joint venture, the department will only count that portion of the total dollar value of the contract equal to that portion of the work that the DBE performs with its own forces.

14. Mentor Protégé

a. If a DBE performs as a participant in a mentor protégé agreement, the department will credit the portion of the work performed by the DBE protégé firm

b. On every other project that the mentor protégé team identifies itself on.

c. For no more than one half of the total contracted DBE goal on any WisDOT project.

15. DBE Replacement

In the event a Prime Contractor needs to replace a DBE firm originally listed on the approved DBE Commitment Form DT1506, the Prime Contractor must comply with the department's DBE Replacement Policy located on the DBE page on the following web site:

http://www.dot.wisconsin.gov/business/engrserv/docs/policyreplacingdbe.pdf

16. Changes to the approved DBE Commitment Form DT1506

If there are any changes to the approved Commitment to Subcontract to DBE Form DT1506, the prime contractor must submit a revised DBE Commitment Form DT1506 and relevant attachment A(s) to the DBE Programs Office within 5 business days.

17. Contract Modifications

When additional opportunity is available by contract modifications, the Prime Contractor shall utilize DBE Subcontractors, that were committed to equal work items, in the original contract.

18. Payment

Costs for conforming to this Additional Special Provision (ASP) and any associated DBE requirements are incidental to the contract.

APPENDIX A
Sample Contractor Solicitation Letter Page 1
This sample is provided as a guide not a requirement

GFW SAMPLE MEMORANDUM

TO: DBE FIRMS

FROM: POTENTIAL PRIME CONTRACTOR OR MAJOR SUBCONTRACTOR

SUBJECT: **REQUEST FOR DBE QUOTES**

LET DATE & TIME

DATE: MONTH DAY YEAR

CC: DBE OFFICE ENGINEER

Our company is considering bidding on the projects indicated on the next page, as a prime and/or a subcontractor for the Wisconsin Department of Transportation Month- date -year Letting. Page 2 lists the projects and work items that we may subcontract for this letting. We are interested in obtaining subcontractor quotes for these projects and work categories. Also note that we are willing to accept quotes in areas we may be planning to perform ourselves as required by federal rules.

Please review page 2, respond whether you plan to quote, highlight the projects and work items you are interested in performing and return it via fax or email within 3 days. Plans, specifications and addenda are available through WisDOT at the DBE Support Services office or at the Highway Construction Contract Information (HCCI) site at http://roadwaystandards.dot.wi.gov/hcci/

Your quote should include all of the costs required to complete the items you propose to perform including labor, equipment, material, and related bonding or insurance. The quote should note items that you are DBE certified to perform, tied items, and any special terms. Page 2, with the indicated projects and items you plan to quote, should be used as a cover sheet for your quote.

Please make every effort to have your quotes into our office by time deadline the prior to the letting date. ***Make sure the correct letting date, project ID and proposal number, unit price and extension are included in your quote.*** We prefer quotes be sent via SBN but prime's alternative's are acceptable. Our office hours are include hours and days. Please call our office as soon as possible prior to the letting if you need information/clarification to prepare your quote at contact number.

If you wish to discuss or evaluate your quote in more detail, contact us after the contract is awarded. Status of the contract can be checked at WisDOT's HCCI site at http://roadwaystandards.dot.wi.gov/hcci/

All questions should be directed to:

Project Manager, John Doe,
Phone: (000) 123-4567
Email: Joe@joetheplumber.com
Fax: (000) 123- 4657

Sample Contractor Solicitation Letter Page 2

This sample is provided as a guide not a requirement

REQUEST FOR QUOTATION

Prime's Name: _____

Letting Date: _____

Project ID: _____

Please check all that apply

- ☐ Yes, we will be quoting on the projects and items listed below
- ☐ No, we are not interested in quoting on the letting or its items referenced below
- ☐ Please take our name off your monthly DBE contact list
- ☐ We have questions about quoting this letting. Please have some one contact me at this number

Prime Contractor 's Contact Person		DBE Contractor Contact Person	
Phone:		Phone	
Fax:		Fax	
Email:		Email	

Please circle the jobs and items you will be quoting below

Proposal No.	1	2	3	4	5	6	7
County							

WORK DESCRIPTION:

Clear and Grub	X		X	X		X	X
Dump Truck Hauling	X		X	X		X	X
Curb & Gutter/Sidewalk, Etc.	X		X	X		X	X
Erosion Control Items	X		X	X		X	X
Signs and Posts/Markers	X		X	X		X	X
Traffic Control		X	X	X		X	X
Electrical Work/Traffic Signals		X	X	X		X	
Pavement Marking		X	X	X	X	X	X
Sawing Pavement		X	X	X	X	X	X
QMP, Base	X	X		X	X	X	X
Pipe Underdrain	X			X			
Beam Guard				X	X	X	X
Concrete Staining							X
Trees/Shrubs	X						X

Again please make every effort to have your quotes into our office by time deadline prior to the letting date.

We prefer quotes be sent via SBN but prime's preferred alternative's are acceptable.

If there are further questions please direct them to the prime contractor's contact person at phone number.

APPENDIX B
BEST PRACTICES FOR PRIME CONTRACTOR & DBE SUBCONTRACTOR GOOD FAITH EFFORT

This list is not a set of requirements; it is a list of potential strategies

Primes

- Prime contractor open houses inviting DBE firms to see the bid "war room" or providing technical assistance
- Participate in speed networking and mosaic exercises as arranged by DBE office
- Host information sessions not directly associated with a bid letting;
- Participate in a formal mentor protégé or joint venture with a DBE firm
- Participate in WisDOT advisory committees i.e. TRANSAC, or Mega Project committee meetings
- Facilitate a small group DBE 'training session' Clarifying how your firm prepares for bid letting, evaluates subcontractors, preferred qualifications and communication methods
- Encourage subcontractors to solicit and highlight DBE participation in their quotes to you
- Quality of communication, not quantity creates the best results. Contractors should do as thorough a job as possible in communicating with DBE firms before the bid and provide any assistance requested to assure best possible bid.

DBE

- DBE firms should contact primes as soon as possible with questions regarding their quotes or bid; seven days prior is optimal.
- Continually check for contract addendums on the HCCI website through the Thursday prior to letting to stay abreast of changes.
- Review the status of contracts on the HCCI website reviewing the 'apparent low bidder' list, and bid tabs at a minimum.
- Prepare a portfolio or list of related projects and prime and supplier references; be sure to note transportation-related projects of similar size and scope, firm expertise and staffing.
- Participate in DBE office assessment programs
- Participate on advisory and mega-project committees
- Sign up to receive the DBE Contracting Update
- Consider membership in relevant industry or contractor organizations
- Active participation is a must. Quote as many projects as you can reasonably work on; quoting the primes and bidding as a prime with the department are the only ways to get work.

APPENDIX C
Types of Efforts considered in determining GFE
This list represents concepts being assessed; analysis requires additional steps

1. Whether the contractor attended any pre-solicitation or pre-bid meetings that were scheduled by WisDOT to inform DBEs of contracting and subcontracting opportunities;
2. Whether the contractor provided written notice to a reasonable number of specific DBEs that their interest in the contract was being solicited, in sufficient time to allow the DBEs to participate effectively;
3. Whether the contractor followed up initial solicitations of interest by contacting DBEs to determine if the DBEs were interested; returned the phone calls of interested DBE firms.
4. Whether the contractor selected portions of the work to be performed by DBEs in order to increase the likelihood of meeting the DBE goal;
5. Whether the contractor provided interested DBEs with adequate information about the plans, specifications and requirements of the contract;
6. Whether the contractor negotiated in good faith with interested DBEs, not rejected DBEs as unqualified without sound reasons based on a thorough investigation of their capabilities;
7. Whether the contractor made efforts to assist interested DBEs in being more competitive.
8. Whether the contractor effectively used the services of available minority community organizations: minority contractors groups, local, state, and Federal minority business assistance offices, and other organizations that provide assistance to small businesses and DBE firms.
9. Whether Prime used CRCS to identify DBE who specialize in relevant work areas.
10. Whether the contractor used available resources including contacting the DBE office, using WisDOT's website
11. Whether the contractor returned calls of firms expressing interest in a timely manner.

APPENDIX D
Good Faith Effort Evaluation Guidance
Excerpt from Appendix A of 49 CFR Part 26

APPENDIX A TO PART 26 -- GUIDANCE CONCERNING GOOD FAITH EFFORTS

I. When, as a recipient, you establish a contract goal on a DOT assisted contract, a bidder must, in order to be responsible and/or responsive, make good faith efforts to meet the goal. The bidder can meet this requirement in either of two ways. First, the bidder can meet the goal, documenting commitments for participation by DBE firms sufficient for this purpose. Second, even if it doesn't meet the goal, the bidder can document adequate good faith efforts. This means that the bidder must show that it took all necessary and reasonable steps to achieve a DBE goal or other requirement of this part which, by their scope, intensity, and appropriateness to the objective, could reasonably be expected to obtain sufficient DBE participation, even if they were not fully successful.

II. In any situation in which you have established a contract goal, part 26 requires you to use the good faith efforts mechanism of this part. As a recipient, it is up to you to make a fair and reasonable judgment whether a bidder that did not meet the goal made adequate good faith efforts. It is important for you to consider the quality, quantity, and intensity of the different kinds of efforts that the bidder has made. The efforts employed by the bidder should be those that one could reasonably expect a bidder to take if the bidder were actively and aggressively trying to obtain DBE participation sufficient to meet the DBE contract goal. Mere pro forma efforts are not good faith efforts to meet the DBE contract requirements. We emphasize, however, that your determination concerning the sufficiency of the firm's good faith efforts is a judgment call: meeting quantitative formulas is not required.

III. The Department also strongly cautions you against requiring that a bidder meet a contract goal (i.e., obtain a specified amount of DBE participation) in order to be awarded a contract, even though the bidder makes an adequate good faith efforts showing. This rule specifically prohibits you from ignoring bona fide good faith efforts.

IV. The following is a list of types of actions which you should consider as part of the bidder's good faith efforts to obtain DBE participation. It is not intended to be a mandatory checklist, nor is it intended to be exclusive or exhaustive. Other factors or types of efforts may be relevant in appropriate cases.

A. Soliciting through all reasonable and available means (e.g. attendance at pre-bid meetings, advertising and/or written notices) the interest of all certified DBEs who have the capability to perform the work of the contract. The bidder must solicit this interest within sufficient time to allow the DBEs to respond to the solicitation. The bidder must determine with certainty if the DBEs are interested by taking appropriate steps to follow up initial solicitations.

B. Selecting portions of the work to be performed by DBEs in order to increase the likelihood that the DBE goals will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate DBE participation, even when the prime contractor might otherwise prefer to perform these work items with its own forces.

C. Providing interested DBEs with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.

D. (1) Negotiating in good faith with interested DBEs. It is the bidder's responsibility to make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBEs that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBEs to perform the work.

(2) A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as contract goals into consideration. However, the fact that there may be some additional costs involved in finding and using DBEs is not in itself sufficient reason for a bidder's failure to meet the contract DBE goal, as long as such costs are reasonable. Also, the ability or desire of a prime contractor to perform the work of a contract with its own organization does not relieve the bidder of the responsibility to make good faith efforts. Prime contractors are not, however, required to accept higher quotes from DBEs if the price difference is excessive or unreasonable.

E. Not rejecting DBEs as being unqualified without sound reasons based on a thorough investigation of their capabilities. The contractor's standing within its industry, membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. non-union employee status) are not legitimate causes for the rejection or non solicitation of bids in the contractor's efforts to meet the project goal.

F. Making efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance as required by the recipient or contractor.

G. Making efforts to assist interested DBEs in obtaining necessary equipment, supplies, materials, or related assistance or services.

H. Effectively using the services of available minority/women community organizations; minority/women contractors' groups; local, state, and Federal minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBEs.

V. In determining whether a bidder has made good faith efforts, you may take into account the performance of other bidders in meeting the contract. For example, when the apparent successful bidder fails to meet the contract goal, but others meet it, you may reasonably raise the question of whether, with additional reasonable efforts, the apparent successful bidder could have met the goal. If the apparent successful bidder fails to meet the goal, but meets or exceeds the average DBE participation obtained by other bidders, you may view this, in conjunction with other factors, as evidence of the apparent successful bidder having made good faith efforts.

Appendix E
Small Business Network [SBN] Overview

The Small Business Network is a part of the Bid Express® service that was created to ensure that prime bidders have a centralized online location to find subs - including small and disadvantaged business enterprises (DBEs). It is available for prime bidders to use as part of their Basic Service subscription. Within the Small Business Network, **Prime Contractors** can:

1. Easily select proposals, work types and items:
    a. After adding applicable work types, select items that you wish to quote. Enter the sub-quote quantities and add comments, if desired. Adding or removing items and work types can be done quickly. If needed, you can save the sub-quote for completion at a later time.
2. Create sub-quotes for the subcontracting community:
    a. Create sub-quotes with ease using the intuitive sub-quote creator. In seven short steps, you can rapidly create a custom sub-quote directed to all subcontractors that bid on the applicable work types. Steps include: provide contact information and sub-quote expiration date, select letting and proposal, add work types and items, specify terms and conditions, upload attachments, and select vendors.
    b. Create a sub-quote to send to subcontractors or suppliers that lists the items in a proposal that you want quoted
    c. Create an unlimited number of sub-quotes for items you want quoted, and optionally mark them as a DBE-preferred request
    d. Add attachments to sub-quotes
3. View sub-quote requests & responses:
    a. After logging into the Bid Express service, you can quickly review all of your sub-quote requests and all unsolicited sub-quote requests from subcontractors. To simplify the Small Business Network home screen, sub-quote requests can be hidden with one click if they are not applicable.
    b. View or receive unsolicited sub-quotes that subcontractors have posted, complete with terms, conditions and pricing
4. View Record of Subcontractor Outreach Effort:
    a. For each sub-quote produced, a *Record of Subcontractor Outreach Effort* is generated that shows the response statistics for a particular sub-quote. If accepted by the letting agency, this report may serve as proof of a "Good Faith" effort in reaching out to the DBE community.
    b. Easily locate pre-qualified and certified small and disadvantaged businesses
    c. Advertise to small and disadvantaged businesses more efficiently and cost effectively
    d. Document your interactions with subs/DBEs by producing an Outreach Report (may be accepted as proof of DBE outreach at the discretion of each agency)

The Small Business Network is a part of the Bid Express® service that was created to ensure that small businesses have a centralized area to access information about upcoming projects. It can help small businesses learn more about opportunities, compete more effectively, network with other contractors and subcontractors, and win more jobs.

1. View and reply to sub-quote requests from primes:
    a. After logging into the Bid Express service, you can quickly review all incoming sub-quote requests and all unsolicited sub-quotes created by your company. Receive notifications by selected work type. To simplify on the Small Business Network home screen, sub-quote requests can be filtered by work types relevant to your interests, or hidden with one click if they are not applicable.
2. Select items when responding to sub-quote requests from primes:
    a. You have the freedom to choose and price any number of items when responding to a sub-quote request. Quantities can be modified, and per-item comments are also available.
    b. View requests for sub-quotes for work that primes have posted for projects they are bidding, add your pricing, terms, and conditions, and submit completed sub-quotes to the requesting primes
    c. Add attachments to a sub-quote
3. Create and send unsolicited sub-quotes to specific contractors:
    a. Create unsolicited sub-quotes with ease using the intuitive sub-quote creator. In eight short steps, you can rapidly create a custom sub-quote directed at any number of specific vendors of your choosing. Steps include: provide contact information and sub-quote expiration date, select letting and proposal, add work types and items, specify terms and conditions, upload attachments, and select vendors.
4. Easily select and price items for unsolicited sub-quotes:
    a. After adding applicable work types, select items that you wish to quote. The extended price calculates automatically, cutting out costly calculation errors. Comments can be provided on an per-item basis as well.
    b. Create an unsolicited sub-quote that lists the items from a proposal that you want to quote, include pricing, terms and conditions, and send it to selected prime/plan holder
    c. Add attachments to a sub-quote
    d. Add unsolicited work items to sub-quotes that you are responding to
5. Easy Access to Valuable Information
    a. Receive a confirmation that your sub-quote was opened by a prime
    b. View Bid Tab Analysis data from past bids, including the high, average and low prices of items.
    c. View important notices and publications from DOT targeted to small and disadvantaged businesses
6. Accessing Small Business Network for WisDOT contracting opportunities
    a. If you are a contractor not yet subscribing to the Bid Express service, go to **www.bidx.com** and select "Order Bid Express." The Small Business Network is a part of the Bid Express Basic Service.
    b. DBE firms can request a Bid Express Small Business Network Account at no cost by calling 414-438-4588

ADDITIONAL SPECIAL PROVISION 4

Payment to First-Tier Subcontractors

Within 10 calendar days of receiving a progress payment for work completed by a subcontractor, pay the subcontractor for that work. The prime contractor may withhold payment to a subcontractor if, within 10 calendar days of receipt of that progress payment, the prime contractor provides written notification to the subcontractor and the department documenting "just cause" for withholding payment.

The prime contractor may also withhold routine retainage from payments due subcontractors.

Payment to Lower-Tier Subcontractors

Ensure that subcontracting agreements at all tiers provide prompt payment rights to lower-tier subcontractors that parallel those granted first-tier subcontractors in this provision.

Release of Routine Retainage

After granting substantial completion the department may reduce the routine retainage withheld from the prime contractor to 75 percent of the original total amount retained.

When the Department sends the semi-final estimate the department may reduce the routine retainage withheld from the prime contractor to 10 percent of the original total amount retained.

Within 30 calendar days of receiving the semi-final estimate from the department, submit written certification that subcontractors at all tiers are paid in full for acceptably completed work and that no routine retainage is being withheld. The department will pay the prime contractor in full and reduce the routine retainage withheld from the prime contractor to zero when the department approves the final estimate.

This special provision does not limit the right of the department, prime contractor, or subcontractors at any tier to withhold payment for work not acceptably completed or work subject to an unresolved contract dispute.

ADDITIONAL SPECIAL PROVISION 6
ASP 6 - Modifications to the standard specifications

Make the following revisions to the standard specifications:

450.3.2.1 General

Replace the entire text with the following effective with the January 2015 letting:

(1) Do not place asphaltic mixture when the air temperature approximately 3 feet above grade, in shade, and away from artificial heat sources is less than 36 F for upper layers or 32 F for lower layers unless the engineer allows in writing. The contractor should place HMA pavement for projects on or north of STH 29 between May 1 and October 15 inclusive and for projects south of STH 29 between April 15 and November 1 inclusive. Notify the engineer at least one business day before paving.

(2) Unless the contract specifies otherwise, conform to the following:

- Keep the road open to all traffic during construction.
- Prepare the existing foundation for treatment as specified in 211.
- Incorporate loose roadbed aggregate as a part of preparing the foundation, in shoulder construction, or dispose of as the engineer approves.

(3) Place asphaltic mixture only on a prepared, firm, and compacted base, foundation layer, or existing pavement substantially surface-dry and free of loose and foreign material. Do not place over frozen subgrade or base, or where the roadbed is unstable.

450.5 Payment

Replace the entire text with the following effective with the January 2015 letting:

(1) All costs of furnishing, maintaining, and operating the truck scale or other weighing equipment and furnishing the weigh tickets are incidental to the contract.

(2) Nonconforming material allowed to remain in place is subject to price adjustment under 105.3.2.

(3) Full-depth sawing to remove integrally placed safety edge where not required is incidental to the contract.

(4) The contractor is responsible for pavement performance. If because of an excusable compensable delay under 108.10.3, the engineer directs the contractor to pave when the temperature is less than 36 F for the upper layer or less than 32 F for lower layers, the department:

- Will relieve the contractor of responsibility for damage and defects the engineer attributes to cold weather paving.
- Will not assess disincentives for density or ride.

455.3.2.1 General

Replace paragraphs one and two with the following effective with the January 2015 letting:

(1) Apply tack coat only when the air temperature is 32 F or more unless the engineer approves otherwise in writing. Before applying tack coat ensure that the surface is dry and reasonably free of loose dirt, dust, or other foreign matter. Do not apply if weather or surface conditions are unfavorable or before impending rains.

(2) Use tack material of the type and grade the contract specifies. The contractor may, with the engineer's approval, dilute tack material as allowed under 455.2.4. Provide calculations using the asphalt content as-received from the supplier and subsequent contractor dilutions to show that as-placed material has 50 percent or more residual asphalt content. Apply at 0.050 to 0.070 gallons per square yard, after dilution, unless the contract designates otherwise. The engineer may adjust the application rate based on surface conditions. Limit application each day to the area the contractor expects to pave during that day.

460.2.2.3 Aggregate Gradation Master Range

Replace paragraph one with the following effective with the December 2014 letting:

(1) Ensure that the aggregate blend, including recycled material and mineral filler, conforms to the gradation requirements in table 460-1. The values listed are design limits; production values may exceed those limits.

TABLE 460-1 AGGREGATE GRADATION MASTER RANGE AND VMA REQUIREMENTS

SIEVE	PERCENTS PASSING DESIGNATED SIEVES						
	NOMINAL SIZE						
	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	SMA 12.5 mm	SMA 9.5 mm
50.0-mm	100						
37.5-mm	90 –100	100					
25.0-mm	90 max	90 -100	100				
19.0-mm	___	90 max	90 -100	100		100	
12.5-mm	___	___	90 max	90 -100	100	90 - 97	100
9.5-mm	___	___	___	90 max	90 -100	58 - 72	90 - 100
4.75-mm	___	___	___	___	90 max	25 - 35	35 - 45
2.36-mm	15 – 41	19 - 45	23 - 49	28 - 58	20 - 65	15 - 25	18 - 28
75-µm	0 – 6.0	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	8.0 - 12.0	10.0 - 14.0
% MINIMUM VMA	11.0	12.0	13.0	14.0[1]	15.0[2]	16.0	17.0

[1] 14.5 for E-0.3 and E-3 mixes.

[2] 15.5 for E-0.3 and E-3 mixes.

460.3.4 Cold Weather Paving

Add a new subsection as follows effective with the January 2015 letting:

460.3.4 Cold Weather Paving

460.3.4.1 Cold Weather Paving Plan

(1) Submit a written cold weather paving plan to the engineer at the preconstruction meeting. In that plan outline material, operational, and equipment changes for paving when the air temperature approximately 3 feet above grade, in shade, and away from artificial heat sources is less than 40 F. Include the following:

- Use a department-accepted HMA mix design that incorporates a warm mix additive from the department's approved products list. Do not use a foaming process.
- Use additional rollers.

(2) Engineer written acceptance is required for the cold weather paving plan. Engineer acceptance of the plan does not relieve the contractor of responsibility for pavement performance except as specified in 450.5(4).

460.3.4.2 Cold Weather Paving Operations

(1) Do not place asphaltic mixture when the air temperature approximately 3 feet above grade, in shade, and away from artificial heat sources is less than 40 F unless a valid engineer-accepted cold weather paving plan is in effect.

(2) If the national weather service forecast for the construction area predicts ambient air temperature less than 40 F at the projected time of paving within the next 24 hours, confirm or submit revisions to a previously engineer-accepted cold weather paving plan for engineer validation. Upon validation of the plan, the engineer will allow paving for the next day. Once in effect, pave conforming to the engineer-accepted cold weather paving plan for the balance of that work day or shift regardless of the temperature at the time of paving.

460.4 Measurement

Add paragraph two as follows effective with the January 2015 letting:

(2) The department will measure HMA Cold Weather Paving by the ton of HMA mixture for pavement placed conforming to an engineer-accepted cold weather paving plan.

460.5.1 General

Revise paragraph one as follows effective with the January 2015 letting:

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
460.1100	HMA Pavement Type E-0.3	TON
460.1101	HMA Pavement Type E-1	TON
460.1103	HMA Pavement Type E-3	TON
460.1110	HMA Pavement Type E-10	TON
460.1130	HMA Pavement Type E-30	TON
460.1132	HMA Pavement Type E-30X	TON
460.1700	HMA Pavement Type SMA	TON
460.2000	Incentive Density HMA Pavement	DOL
460.4000	HMA Cold Weather Paving	TON

460.5.2.2 Disincentive for HMA Pavement Density

Revise paragraph two as follows effective with the January 2015 letting:

(2) The department will not assess density disincentives for pavement placed in cold weather because of a department-caused delay as specified in 450.5(4).

460.5.2.4 Cold Weather Paving

Add a new subsection as follows effective with the January 2015 letting:

460.5.2.4 Cold Weather Paving

(1) Payment for HMA Cold Weather Paving is full compensation for additional materials and equipment specified for cold weather paving under 460.3.4 including costs for preparing, administering, and following the contractor's cold weather paving plan.

(2) If HMA pavement is placed under 460.3.4 and the HMA Cold Weather Paving bid item is not in the contract, the department will pay for the additional costs specified in 460.5.2.4(1) as extra work. The department will pay separately for HMA pavement under the appropriate HMA Pavement bid items.

465.2 Materials

Replace paragraph two with the following effective with the December 2014 letting:

(2) Under the other section 465 bid items, the contractor need not submit a mix design. Furnish aggregates mixed with a type AC asphaltic material, except under the Asphaltic Curb bid item furnish PG58-28 asphaltic material. Use coarse and fine mineral aggregates uniformly coated and mixed with the asphaltic material in an engineer-approved mixing plant. The contractor may include reclaimed asphaltic pavement materials in the mixture.

Bid Items Added

Add the following new bid item effective with the January 2015 letting:

ITEM NUMBER	DESCRIPTION	UNIT
460.4000	HMA Cold Weather Paving	TON

Errata

Make the following corrections to the standard specifications:

501.3.2.4.4 Water Reducer

Correct errata by deleting the reference to footnote 6 for grade D concrete.

(1) Add a water reducing admixture conforming to 501.2.3. Determine the specific type and rate of use based on the atmospheric conditions, the desired properties of the finished concrete and the manufacturer's recommended rate of use. The actual rate of use shall at least equal the manufacturer's recommended rate, and both the type and rate used require the engineer's approval before use.

APRIL 2013

BUY AMERICA PROVISION

All steel and iron materials permanently incorporated in this project shall be domestic products and all manufacturing and coating processes for these materials from smelting forward in the manufacturing process must have occurred within the United States. Coating includes epoxy coating, galvanizing, painting and any other coating that protects or enhances the value of a material subject to the requirements of Buy America. The exemption of this requirement is the minimal use of foreign materials if the total cost of such material permanently incorporated in the product does not exceed one-tenth of one percent (1/10 of 1%) of the total contract cost or $2,500.00, whichever is greater. For purposes of this paragraph, the cost is that shown to be the value of the subject products as they are delivered to the project. The contractor shall take actions and provide documentation conforming to CMM 2-28.4 to ensure compliance with this “Buy America” provision.

http://roadwaystandards.dot.wi.gov/standards/cmm/cm-02-28.pdf#cm2-28.4

Upon completion of the project certify to the engineer, in writing using department form WS4567, that all steel, iron, and coating processes for steel or iron incorporated into the contract work conform to these "Buy America" provisions. Attach a list of exemptions and their associated costs to the certification form. Department form WS4567 is available at:

http://roadwaystandards.dot.wi.gov/standards/forms/hidden/ws4567.doc

Buy America Certification

WS4567 2/15/12

Wisconsin Department of Transportation

Project ID: _____ Highway: _____ County: _____

Name of Road/Project: _____

Prime Contractor: _____

Address: _____

Contact Person: _____ Phone: _____

DOT Project Manager: _____ Project Leader: _____

The undersigned certifies that only domestic steel and iron was permanently incorporated into the construction portion of the Project.

To be considered domestic, all steel and iron used and all products manufactured from steel and iron must be produced in the United States. This includes smelting, coating, bending, shaping, and all other manufacturing processes performed on the product. Coating includes all processes which protect or enhance the value of the material to which the coating is applied.

This requirement does not preclude a minimal use of foreign steel and iron materials, provided the cost of such materials does not exceed 0.1 percent of the Contract Price.

Signature _____

Typed or Printed Name _____

Title _____

Date _____

NON-TRADITIONAL TRANSPORTATION PROJECT IMPLEMENTATION PROGRAM CONTRACT MODIFICATION

WISCONSIN DEPARTMENT OF TRANSPORTATION

Date:

Contract Modification #

Project ID:

Sponsor:

Project Description:

Contractor:

Region:

Region Representative:

Description of Changes:

Bid Item Increases/Decreases:

Item Number	Unit	Original Quantity	Revised Quantity	Unit Price	Total Cost Increase/Decrease	Participating Yes/No
					$0.00	
					$0.00	
					$0.00	
					$0.00	
				Subtotal	$0.00	

New Items:

Item Number	Unit	Original Quantity	Revised Quantity	Unit Price	Total Cost Increase/Decrease	Participating Yes/No
					$0.00	
					$0.00	
					$0.00	
					$0.00	
				Subtotal	0.00	
			Total Contract Increase/Decrease		**0.00**	

Original Contract Amount: $0.00

Let amount from Bid Letting

Revised Contract Amount $0.00

Total Non-Participating Cost	$0.00
Non-Participating Costs are funded by the Sponsor and are not eligible for reimbursement.	
Total Participating Cost	$0.00
(Subtract Non-Participating Cost from Revised Cost)	
Participating Costs are costs eligible for State or Federal cost sharing and approved for inclusion in this project.	
Multiply by Maximum Participating Percentage	80%
(See Project Agreement; usually 80%)	
Revised Participating Cost	$0.00
Maximum Participating Cost	$0.00
(See Project Agreement)	

Recommended By:		Accepted By:
Signature of Engineer		Signature of Contractor
Approved By:		Approved By:
Signature of Sponsor		Signature of Region

DECEMBER 2000

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS - PRIMARY COVERED TRANSACTIONS

Instructions for Certification

1. By signing and submitting this proposal, the prospective contractor is providing the certification set out below.

2. The inability of a person to provide the certification required below will not necessarily result in denial of participation in this covered transaction. The prospective contractor shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective contractor to furnish a certification or an explanation shall disqualify such person from participation in this transaction.

3. The certification in this clause is a material representation of fact upon which reliance was placed when the department determined to enter into this transaction. If it is later determined that the contractor knowingly rendered an erroneous certification in addition to other remedies available to the Federal Government the department may terminate this transaction for cause or default.

4. The prospective contractor shall provide immediate written notice to the department to whom this proposal is submitted if at any time the prospective contractor learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

5. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549. You may contact the department to which this proposal is being submitted for assistance in obtaining a copy of those regulations.

6. The prospective contractor agrees by submitting this proposal that, should this contract be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department entering into this transaction.

7. The prospective contractor further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," which is included as an addendum to PR-1273 - "Required Contract Provisions Federal Aid Construction Contracts," without

modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

8. The contractor may rely upon a certification of a prospective subcontractor/materials supplier that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A contractor may decide the method and frequency by which it determines the eligibility of its principals. Each contractor may, but is not required to, check the Disapproval List (telephone # 608/266/1631).

9. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a contractor is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

10. Except for transactions authorized under paragraph 6 of these instructions, if a contractor in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department may terminate this transaction for cause or default.

Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions

(1) The prospective contractor certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offense enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective contractor is unable to certify to any of the statements in this certification, such prospective contractor shall attach an explanation to this proposal.

Effective with November 2007 Letting

PROPOSAL REQUIREMENTS AND CONDITIONS

The bidder, signing and submitting this proposal, agrees and declares as a condition thereof, to be bound by the following conditions and requirements.

If the bidder has a corporate relationship with the proposal design engineering company, the bidder declares that it did not obtain any facts, data, or other information related to this proposal from the design engineering company that was not available to all bidders.

The bidder declares that they have carefully examined the site of, and the proposal, plans, specifications and contract forms for the work contemplated, and it is assumed that the bidder has investigated and is satisfied as to the conditions to be encountered, as to the character, quality, and quantities of work to be performed and materials to be furnished, and as to the requirements of the specifications, special provisions and contract. It is mutually agreed that submission of a proposal shall be considered conclusive evidence that the bidder has made such examination.

The bidder submits herewith a proposal guaranty in proper form and amount payable to the party as designated in the advertisement inviting proposals, to be retained by and become the property of the owner of the work in the event the undersigned shall fail to execute the contract and contract bond and return the same to the office of the engineer within fourteen (14) days after having been notified in writing to do so; otherwise to be returned.

The bidder declares that they understand that the estimate of quantities in the attached schedule is approximate only and that the attached quantities may be greater or less in accordance with the specifications.

The bidder agrees to perform the said work, for and in consideration of the payment of the amount becoming due on account of work performed, according to the unit prices bid in the following schedule, and to accept such amounts in full payment of said work.

The bidder declares that all of the said work will be performed at their own proper cost and expense, that they will furnish all necessary materials, labor, tools, machinery, apparatus, and other means of construction in the manner provided in the applicable specifications and the approved plans for the work together with all standard and special designs that may be designed on such plans, and the special provisions in the contract of which this proposal will become a part, if and when accepted. The bidder further agrees that the applicable specifications and all plans and working drawings are made a part hereof, as fully and completely as if attached hereto.

The bidder, if awarded the contract, agrees to begin the work not later than ten (10) days after the date of written notification from the engineer to do so, unless otherwise stipulated in the special provisions.

The bidder declares that if they are awarded the contract, they will execute the contract agreement and begin and complete the work within the time named herein, and they will file a good and sufficient surety bond for the amount of the contract for performance and also for the full amount of the contract for payment.

The bidder, if awarded the contract, shall pay all claims as required by Section 779.14, Statutes of Wisconsin, and shall be subject to and discharge all liabilities for injuries pursuant to Chapter 102 of the Statutes of Wisconsin, and all acts amendatory thereto. They shall further be responsible for any damages to property or injury to persons occurring through their own negligence or that of their employees or agents, incident to the performance of work under this contract, pursuant to the Standard Specifications for Road and Bridge Construction applicable to this contract.

In connection with the performance of work under this contract, the contractor agrees to comply with all applicable state and federal statutes relating to non-discrimination in employment. No otherwise qualified person shall be excluded from employment or otherwise be subject to discrimination in employment in any manner on the basis of age, race, religion, color, gender, national origin or ancestry, disability, arrest or conviction record (in keeping with s.111.32), sexual orientation, marital status, membership in the military reserve, honesty testing, genetic testing, and outside use of lawful products. This provision shall include, but not be limited to the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation, and selection for training, including apprenticeship. The contractor further agrees to ensure equal opportunity in employment to all applicants and employees and to take affirmative action to attain a representative workforce.

The contractor agrees to post notices and posters setting forth the provisions of the nondiscrimination clause, in a conspicuous and easily accessible place, available for employees and applicants for employment.

If a state public official (section 19.42, Stats.) or an organization in which a state public official holds at least a 10% interest is a party to this agreement, this contract is voidable by the state unless appropriate disclosure is made to the State of Wisconsin Ethics Board.

REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

I. General
II. Nondiscrimination
III. Nonsegregated Facilities
IV. Davis-Bacon and Related Act Provisions
V. Contract Work Hours and Safety Standards Act Provisions
VI. Subletting or Assigning the Contract
VII. Safety: Accident Prevention
VIII. False Statements Concerning Highway Projects
IX. Implementation of Clean Air Act and Federal Water Pollution Control Act
X. Compliance with Governmentwide Suspension and Debarment Requirements
XI. Certification Regarding Use of Contract Funds for Lobbying

ATTACHMENTS

A. Employment and Materials Preference for Appalachian Development Highway System or Appalachian Local Access Road Contracts (included in Appalachian contracts only)

I. GENERAL

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23 (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services).

The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services). The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Contracting agencies may reference Form FHWA-1273 in bid proposal or request for proposal documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract).

2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.

4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors.

II. NONDISCRIMINATION

The provisions of this section related to 23 CFR Part 230 are applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR 60, 29 CFR 1625-1627, Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding $10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR 60, and 29 CFR 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), and Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR 230, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. Equal Employment Opportunity: Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, 29 CFR 1625-1627, 41 CFR 60 and 49 CFR 27) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under

this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract.

b. The contractor will accept as its operating policy the following statement:

"It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."

2. EEO Officer: The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.

3. Dissemination of Policy: All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.

b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.

c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. Recruitment: When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.

a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.

b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.

c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.

5. Personnel Actions: Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:

a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.

6. Training and Promotion:

a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are

applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.

b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).

c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. Unions: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:

a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.

b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.

c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.

8. Reasonable Accommodation for Applicants / Employees with Disabilities: The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.

9. Selection of Subcontractors, Procurement of Materials and Leasing of Equipment: The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.

a. The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.

b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.

10. Assurance Required by 49 CFR 26.13(b):

a. The requirements of 49 CFR Part 26 and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.

b. The contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the contracting agency deems appropriate.

11. Records and Reports: The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;

(2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;

b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. The staffing data should represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor

will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more.

The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, washrooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding $2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size). The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. Contracting agencies may elect to apply these requirements to other projects.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 “Contract provisions and related matters” with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

1. Minimum wages

a. All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph 1.d. of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph 1.b. of this section) and the Davis-Bacon poster (WH–1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

b.(1) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(ii) The classification is utilized in the area by the construction industry; and

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(2) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(3) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. The Wage and Hour Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or

will notify the contracting officer within the 30-day period that additional time is necessary.

(4) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 1.b.(2) or 1.b.(3) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

c. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

d. If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding

The contracting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract, or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the contracting agency may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and basic records

a. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

b.(1) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g. , the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the contracting agency for transmission to the State DOT, the FHWA or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the contracting agency..

(2) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(i) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(2) of this section.

(4) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

c. The contractor or subcontractor shall make the records required under paragraph 3.a. of this section available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the FHWA may, after written notice to the contractor, the contracting agency or the State DOT, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and trainees

a. Apprentices (programs of the USDOL).

Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice.

The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

b. Trainees (programs of the USDOL).

Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration.

Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

d. Apprentices and Trainees (programs of the U.S. DOT).

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

5. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

6. Subcontracts. The contractor or subcontractor shall insert Form FHWA-1273 in any subcontracts and also require the subcontractors to include Form FHWA-1273 in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

7. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of eligibility.

a. By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

b. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

The following clauses apply to any Federal-aid construction contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (1.) of this section, the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1.) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1.) of this section.

3. Withholding for unpaid wages and liquidated damages. The FHWA or the contacting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2.) of this section.

4. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (1.) through (4.) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1.) through (4.) of this section.

VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).

a. The term “perform work with its own organization” refers to workers employed or leased by the prime contractor, and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor or lower tier subcontractor, agents of the prime contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime contractor meets all of the following conditions:

(1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;
(2) the prime contractor remains responsible for the quality of the work of the leased employees;
(3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and
(4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

5. The 30% self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements.

VII. SAFETY: ACCIDENT PREVENTION

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).

3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.3704).

VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

By submission of this bid/proposal or the execution of this contract, or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any person who is or will be utilized in the performance of this contract is not prohibited from receiving an award due to a violation of Section 508 of the Clean Water Act or Section 306 of the Clean Air Act.
2. That the contractor agrees to include or cause to be included the requirements of paragraph (1) of this Section X in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements.

X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost $25,000 or more – as defined in 2 CFR Parts 180 and 1200.

1**. Instructions for Certification – First Tier Participants:**

a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.

b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.

c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default.

d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. “First Tier Covered Transactions” refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

i. Nothing contained in the foregoing shall be construed to require the establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of the prospective participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

* * * * *

2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:

a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency;

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

2. **Instructions for Certification - Lower Tier Participants:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions requiring prior FHWA approval or estimated to cost $25,000 or more - 2 CFR Parts 180 and 1200)

a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. “First Tier Covered Transactions” refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the

department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

* * * * *

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

* * * * *

XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed $100,000 (49 CFR 20).

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

ATTACHMENT A - EMPLOYMENT AND MATERIALS PREFERENCE FOR APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM OR APPALACHIAN LOCAL ACCESS ROAD CONTRACTS

This provision is applicable to all Federal-aid projects funded under the Appalachian Regional Development Act of 1965.

1. During the performance of this contract, the contractor undertaking to do work which is, or reasonably may be, done as on-site work, shall give preference to qualified persons who regularly reside in the labor area as designated by the DOL wherein the contract work is situated, or the subregion, or the Appalachian counties of the State wherein the contract work is situated, except:

a. To the extent that qualified persons regularly residing in the area are not available.

b. For the reasonable needs of the contractor to employ supervisory or specially experienced personnel necessary to assure an efficient execution of the contract work.

c. For the obligation of the contractor to offer employment to present or former employees as the result of a lawful collective bargaining contract, provided that the number of nonresident persons employed under this subparagraph (1c) shall not exceed 20 percent of the total number of employees employed by the contractor on the contract work, except as provided in subparagraph (4) below.

2. The contractor shall place a job order with the State Employment Service indicating (a) the classifications of the laborers, mechanics and other employees required to perform the contract work, (b) the number of employees required in each classification, (c) the date on which the participant estimates such employees will be required, and (d) any other pertinent information required by the State Employment Service to complete the job order form. The job order may be placed with the State Employment Service in writing or by telephone. If during the course of the contract work, the information submitted by the contractor in the original job order is substantially modified, the participant shall promptly notify the State Employment Service.

3. The contractor shall give full consideration to all qualified job applicants referred to him by the State Employment Service. The contractor is not required to grant employment to any job applicants who, in his opinion, are not qualified to perform the classification of work required.

4. If, within one week following the placing of a job order by the contractor with the State Employment Service, the State Employment Service is unable to refer any qualified job applicants to the contractor, or less than the number requested, the State Employment Service will forward a certificate to the contractor indicating the unavailability of applicants. Such certificate shall be made a part of the contractor's permanent project records. Upon receipt of this certificate, the contractor may employ persons who do not normally reside in the labor area to fill positions covered by the certificate, notwithstanding the provisions of subparagraph (1c) above.

5. The provisions of 23 CFR 633.207(e) allow the contracting agency to provide a contractual preference for the use of mineral resource materials native to the Appalachian region.

6. The contractor shall include the provisions of Sections 1 through 4 of this Attachment A in every subcontract for work which is, or reasonably may be, done as on-site work.

March 2010

LIST OF SUBCONTRACTORS

Section 66.0901(7), Wisconsin Statutes, provides that as a part of the proposal, the bidder also shall submit a list of the subcontractors the bidder proposes to contract with and the class of work to be performed by each. In order to qualify for inclusion in the bidder's list a subcontractor shall first submit a bid in writing, to the general contractor at least 48 hours prior to the time of the bid closing. The list may not be added to or altered without the written consent of the municipality. A proposal of a bidder is not invalid if any subcontractor and the class of work to be performed by the subcontractor has been omitted from a proposal; the omission shall be considered inadvertent or the bidder will perform the work personally.

No subcontract, whether listed herein or later proposed, may be entered into without the written consent of the Engineer as provided in Subsection 108.1 of the Standard Specifications.

Name of Subcontractor	Class of Work	Estimated Value

Effective with September 2004 Letting

WISCONSIN DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS AND TRANSPORTATION FACILITIES

SUPPLEMENTAL REQUIRED CONTRACT PROVISIONS

I. Wage Rates, Hours of labor and payment of Wages
II. Payroll Requirements
III. Postings at the Site of the Work
IV. Affidavits
V. Wage Rate Redistribution
VI. Additional Classifications

I. WAGE RATES, HOURS OF LABOR AND PAYMENT OF WAGES

The schedule of "Minimum Wage Rates" attached hereto and made a part hereof furnishes the prevailing wage rates that have been determined pursuant to Section 103.50 of the Wisconsin Statutes. These wage rates are the minimum required to be paid to the various laborers, workers, mechanics and truck drivers employed by contractors and subcontractors on the construction work embraced by the contract and subject to prevailing hours and wages under Section 103.50, Stats. If necessary to employ laborers, workers, mechanics or truck drivers whose classification is not listed on the schedule, they shall be paid at rates conformable to those listed for similar classifications. Apprentices shall be paid at rates not less than those prescribed in their state indenture contacts.

While the wage rates shown are the minimum rates required by the contract to be paid during its life, this in not a representation that labor can be obtained at these rates. It is the responsibility of bidders to inform themselves as to the local labor conditions and prospective changes or adjustments of wage rates. No increase in the contract price shall be allowed or authorized on account of the payment of wage rates in excess of those listed herein.

Pursuant to Section 103.50 of the Wisconsin Statutes, the prevailing hours of labor have been determined to be up to 10 hours per day and 40 hours per calendar week Monday through Friday. If any laborer, worker, mechanic or truck driver is permitted or required to work more than the prevailing number of hours per day or per calendar week on this contract, they shall be paid for all hours in excess of the prevailing hours at a rate of at least one and one-half (1 1/2) times their hourly rate of pay. All work on Saturday, Sunday and the following holidays is to be paid at time and a half: (1) January 1, (2) the last Monday in May, (3) July 4, (4) the first Monday in September, (5) the fourth Thursday in November, (6) December 25, (7) the day before if January 1, July 4 or December 25 falls on a Saturday and (8) the day following if January 1, July 4 or December 25 falls on a Sunday.

All laborers, workers, mechanics and truck drivers shall be paid unconditionally not less often than once a week. Persons who own and operate their own trucks must receive the prevailing truck driver rate for the applicable type of truck (i.e. 2 axle, 3 or more axle, articulated, eculid or dumptor) he or she operates, plus an agreed upon amount for the use of his or her truck. Every owner-operator MUST be paid separately for their driving and for the use of their truck.

For those projects subject to the requirements of the Davis-Bacon Act, the Secretary of Labor will also have determined "Minimum Wage Rates" for work to be performed under the contract. These rates are, for all or most of the labor, worker, mechanic or truck driver classifications, identical to those established under Section 103.50 of the Wisconsin Statutes. In the event the rates are not identical, the higher of the two rates will govern.

II. PAYROLL REQUIREMENTS

All contractors and subcontractors must submit weekly Certified Payrolls and Compliance Statement verifying that all laborers, workers, mechanics and truck drivers working on the project have been paid the prevailing wage rates for all work performed under the contract required by Section 103.50 of the Wisconsin Statutes.

III. POSTINGS AT THE SITE OF THE WORK

In addition to the required postings furnished by the Department, the contractor shall post the following in at least one conspicuous place at the site of work:

a. "NOTICE TO EMPLOYEES," which provides information required to be posted by the provisions of Section 103.50 of the Wisconsin Statutes.

b. A copy of the State of Wisconsin Minimum Wages Rates. (Four pages.)

c. A copy of the contractor's Equal Employment Opportunity Policy.

d. On any project involving federal aid, in addition to the furnished postings, the contractor shall post a copy of the "Davis-Bacon Act, Minimum Wage Rates". (Three pages.)

IV. WAGE RATE REDISTRIBUTION

The amount specified as the hourly basic rate of pay and the amount(s) specified as the fringe benefit contribution(s), for all classes of laborers, workers, mechanics or truck drivers may be redistributed, when necessary, to conform to those specified in any applicable collective bargaining agreement, provided that both parties to such agreement

request and receive the approval for any such redistribution from both the Department of Transportation and the Department of Workforce Development prior to the implementation of such redistribution.

V. ADDITIONAL CLASSIFICATIONS

Any unlisted laborer or mechanic classification that is needed to perform work on this project, and is not included within the scope of any of the classifications listed in the application prevailing wage rate determination, may be added after award only if all of the following criteria have been met:

1. The affected employer(s) must make a written request to WisDOT Central Office to utilize the unlisted classification on this project.

2. The request must indicate the scope of the work to be performed by the unlisted classification and must indicate the proposed wage/fringe benefit package that the unlisted classification is to receive.

3. The work to be performed by the unlisted classification must not be performed by a classification that is included in the applicable prevailing wage rate determination.

4. The unlisted classification must be commonly employed in the area where the project is located.

5. The proposed wage/fringe benefit package must bear a reasonable relationship to those set forth in the applicable prevailing wage rate determination.

6. The request should be made prior to the actual performance of the work by the unlisted classification.

7. DWD must approve the use of the unlisted classification and the proposed wage/fringe benefit package. USDOL also must approve the use of the unlisted classification and the proposed wage/fringe benefit package on federal aid projects.

8. WisDOT and DWD may amend the proposed wage/fringe benefit package, as deemed necessary, and may set forth specific employment ratios and scope of work requirements in the approval document.

The approved wage/fringe benefit package shall be paid to all laborers, workers, mechanics or truck drivers performing work within the scope of that performed by the unlisted classification, from the first day on which such work is performed. In the event that work is performed by the unlisted classification prior to approval, the wage/fringe benefit package to be paid for such work must be in conformance with the wage/fringe

benefit package approved for such work. Under this arrangement a retroactive adjustment in wages and/or fringe benefits may be required to be made to the affected laborers, workers, mechanics or truck drivers by the affected employer(s).

APPENDIX B
WI DNR CERTIFICATE OF PERMIT COVERAGE

PART 1 GENERAL

1.1 SUMMARY

A. See the following attached WI DNR Certificate of Permit Coverage:

END OF SECTION

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
Waukesha Service Center
141 NW Barstow St., Room 180
Waukesha, WI 53188

Scott Walker, Governor
Cathy Stepp, Secretary
Eric Nitschke, Regional Director
Telephone (262) 574-2100
FAX (262) 574-2117
TDD () -

December 13, 2013

Mr. Thomas Tarkowski, P.E.
City of Milwaukee
841 N. Broadway, Room 602
Milwaukee WI 53202

SUBJECT: Coverage Under WPDES General Permit No. WI-S067831-04: Construction Site Storm Water Runoff

Permittee Name:	City of Milwaukee
Site Name:	NW Garage CNG Fueling Station
FIN:	49910

Dear Mr. Tarkowski:

The Wisconsin Department of Natural Resources received your Water Resources Application for Project Permits or Notice of Intent, on December 9, 2013, for the Nw Garage CNG Fueling Station site and has evaluated the information provided regarding storm water discharges from your construction site. We have determined that your construction site activities will be regulated under ch. 283, Wis. Stats., ch. NR 216, Wis. Adm. Code, and in accordance with Wisconsin Pollutant Discharge Elimination System (WPDES) General Permit No. WI-S067831-04, Construction Site Storm Water Runoff. All erosion control and storm water management activities undertaken at the site must be done in accordance with the terms and conditions of the general permit.

The **Start Date** of permit coverage for this site is December 13, 2013. The maximum period of permit coverage for this site is limited to 3 years from the **Start Date**. Therefore, permit coverage automatically expires and terminates 3 years from the Start Date and storm water discharges are no longer authorized unless another Notice of Intent and application fee to retain coverage under this permit or a reissued version of this permit is submitted to the Department 14 working days prior to expiration.

A copy of the general permit along with extensive storm water information including technical standards, forms, guidance and other documents is accessible on the Department's storm water program Internet site. To obtain a copy of the general permit, please download it and the associated documents listed below from the following Department Internet site: **http://dnr.wi.gov/topic/stormwater/construction/forms.html**

- Construction Site Storm Water Runoff WPDES general permit No. WI-S067831-04
- Construction site inspection report form
- Notice of Termination form

If, for any reason, you are unable to access these documents over the Internet, please contact me and I will send them to you.

To ensure compliance with the general permit, please read it carefully and be sure you understand its contents. Please take special note of the following requirements (This is not a complete list of the terms and conditions of the general permit.):

1. The Construction Site Erosion Control Plan and Storm Water Management Plan that you completed prior to submitting your permit application must be implemented and maintained throughout construction. Failure to do so may result in enforcement action by the Department.

2. The general permit requires that erosion and sediment controls be routinely inspected at least every 7 days, and within 24 hours after a rainfall event of 0.5 inches or greater. Weekly written reports of all inspections must be maintained. The reports must contain the following information:

a. Date, time, and exact place of inspection;
b. Name(s) of individual(s) performing inspection;
c. An assessment of the condition of erosion and sediment controls;
d. A description of any erosion and sediment control implementation and maintenance performed;
e. A description of the site's present phase of construction.

3. A **Certificate of Permit Coverage** must be posted in a conspicuous place on the construction site. The Certificate of Permit Coverage (WDNR Publication # WT-813) is enclosed for your use.

4. When construction activities have ceased and the site has undergone final stabilization, a Notice of Termination (NOT) of coverage under the general permit must be submitted to the Department.

It is important that you read and understand the terms and conditions of the general permit because they have the force of law and apply to you. Your project may lose its permit coverage if you do not comply with its terms and conditions. The Department may also withdraw your project from coverage under the general permit and require that you obtain an individual WPDES permit instead, based on the Department's own motion, upon the filing of a written petition by any person, or upon your request.

If you believe that you have a right to challenge this decision to grant permit coverage, you should know that the Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed. For judicial review of a decision pursuant to ss. 227.52 and 227.53, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review must name the Department of Natural Resources as the respondent.

To request a contested case hearing pursuant to s. 227.42, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. All requests for contested case hearings must be made in accordance with s. NR 2.05(5), Wis. Adm. Code, and served on the Secretary in accordance with s. NR 2.03, Wis. Adm. Code. The filing of a request for acontested case hearing is not a prerequisite for judicial review and does not extend the 30-day period for filing a petition for judicial review.

Thank you for your cooperation with the Construction Site Storm Water Discharge Permit Program. If you have any questions concerning the contents of this letter or the general permit, please contact me at (262) 574-2129.

Sincerely,

/s/ *Bryan Hartsook*

Bryan Hartsook, P.E.
Southeast Region
Water Resources Engineer

ENCLOSURE: Certificate of Permit Coverage

CERTIFICATE OF PERMIT COVERAGE

UNDER THE
WPDES CONSTRUCTION SITE STORM WATER RUNOFF PERMIT
Permit No. WI-S067831-04

Under s. NR 216.455(2), Wis. Adm. Code, landowners of construction sites with storm water discharges regulated by the Wisconsin Department of Natural Resources (WDNR) Storm Water Permit Program are required to post this certificate in a conspicuous place at the construction site. This certifies that the site has been granted WDNR storm water permit coverage. The landowner must implement and maintain erosion control practices to limit sediment-contaminated runoff to waters of the state in accordance with the permit.

EROSION CONTROL COMPLAINTS

should be reported to the WDNR Tip Line at

1-800-TIP-WDNR (1-800-847-9367)

Please provide the following information to the Tip Line:

WDNR Site No. (FIN): 49910

Site Name: Nw Garage CNG Fueling Station

Address/Location: 3025 W. Ruby Ave. City of MILWAUKEE

Additional Information:

Landowner: City of Milwaukee Site

Landowner's Contact Person: Thomas Tarkowski, P.E.

Contact Telephone Number: (414) 286-3295

Permit Start Date: December 13, 2013

By: /s/ *Bryan Hartsook*

WDNR Publication # WT-813 (10/11)

SECTION 024100
DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Protection of public properties/utilities and existing adjacent private structures/features.
   2. Disconnection of utility services to building.
   3. Demolition of buildings and surface features indicated.
   4. Removal of demolition material from site.

B. Related Sections:
   1. Section 315000 - Excavation Support and Protection.
   2. Section 312000 - Earthwork.
   3. Section 312300 - Excavation and Fill.
   4. Section 333000 – Sanitary Sewerage Utilities.

1.2 CONDITION AND ACCEPTANCE OF PREMISES

A. Accept premises as existing. Accept buildings to be demolished upon execution of Contract with Owner. No damage or loss shall relieve Contractor from obligation to complete work under this Contract.

B. Where the work of removals, demolition, cutting and similar work involves possible hazardous substances or harmful physical agents, such as asbestos fibers, exercise extreme care to avoid damage and preserve safety of personnel. Notify Owner before making removals or cutting such material so that tests of such substances may be taken in order to ascertain whether asbestos fibers exist. Accomplish removal or cutting work involving such material by competent and qualified personnel as contracted and approved by Owner, including barriers to isolate area. Owner will pay for hazardous material removal and disposal, unless the hazardous substance or harmful physical agents have been generated or caused to be on Project by Contractor.

1.3 PROTECTION AND SAFETY

A. Execute work in a manner to prevent injury or damage to public or private property. Prevent damage from falling debris or other cause. Do not interfere with use of adjacent buildings or free, safe passage to and from same.

B. Furnish temporary sidewalks, barricades, covers and other temporary structures necessary for proper and safe conduct of work, or as required by law. Remove without additional compensation.

C. Protect trees, whenever possible, from damage. Repair injuries to bark, trunk and branches of trees by dressing, cutting and painting by skilled specialist. When so directed by Architect/Engineer (A/E), remove trees which have been injured; additional compensation will be provided by Change Order to Contract.

D. Do not drop material from great height, but lower by appropriate demolition equipment or by enclosed duct chutes. Where multi-story buildings are being demolished, enclosed chutes shall include control gates to govern flow of materials into receiving trucks. Sprinkle during demolition operations to allay dust.

E. Take precautions to prevent movement or settlement of adjacent structures, streets, walks, and similar work; provide and place adequate bracing, shoring or supports. Be responsible for complete safety of nearby buildings and assume liability for damage, movement, settlement or similar injury resulting from operations or work under contract. If safety of nearby buildings or other work appears endangered, stop work and take corrective or preventative measures to eliminate possibilities of damage, injury, settlement or movement. Conform to instructions from Municipality regarding safety, additional precautions, additional bracing or shoring and similar protective measures. Support provisions shall be adequate and be carried to lower levels or grade as required to insure complete safety and prevent settlement.

F. Provide warning lights and other lighting as required to permit safe pedestrian traffic.

G. Exercise prudent operation with heavy equipment to prevent damage when working adjacent to existing buildings. Govern operations accordingly.

H. Use planking or other approved methods to protect sidewalks adjacent to property from damage due to demolition operations, including trucks and equipment. Repair damage to walks with equal or better materials by licensed concrete contractor.

1.4 PERMITS AND REGULATIONS

A. Review and comply with national, state and local standards and regulations including, but not limited to, pollution control standards.

B. Apply and pay for permits necessary to perform work.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Use appropriate equipment to obtain results expected, considering safety and expeditious methods and operations.

B. Use of explosives is not permitted.

PART 3 EXECUTION

3.1 RODENT AND PEST EXTERMINATION

A. Rodent and pest extermination to premises and existing structure or building shall be under the control of a Contractor or subcontractor licensed by the State or Municipal Health Department or Environmental Agency having jurisdiction.

B. Proper and safe use of rodenticide shall be in accordance with manufacturer's latest printed directions and with State or Municipal laws, ordinances and regulations. During and after rodent and pest control has begun, safeguard building from unlawful entrance until certificate from the State or Municipality Health Department has certified that rodents and pest nuisances have been exterminated within structures and premises.

C. Properly dispose of dead rodents, pest nuisance, bait, poison and similar items before demolition or wrecking operations begin.

3.2 EXISTING UTILITIES AND UNDERGROUND FEATURES

A. Contact municipal authorities and utility companies with jurisdiction in the area. Have utility companies verify and locate utility lines within the construction limits prior to initiating work.

B. Seal off openings which extend beyond building or property lines with 12-inch concrete block and mortar. Seal vertical shafts, tunnel openings and cave openings within property in same manner.

C. Plug building sewers and cap other utility lines. Contact utility companies for approved methods of plugging and capping utility lines.

D. Do not start demolition until services have been cut off, sealed, capped, removed or otherwise made inoperative by Contractor or applicable Utility Company representative. Protect seals, caps, stubs or similar services to remain.

3.3 DEMOLITION

A. Remove exterior walls and foundation walls to a level of 4 feet below grade of adjoining ground. At areas of proposed buildings or paved surfaces, remove walls and floors completely. Do not disturb or undermine adjacent private property or street right-of-way. Remove common walls supporting public sidewalks or private improvements down to sidewalk or private property grade. Do not permit wall or part thereof to fall outwardly onto public sidewalks or streets.

1. Demolish, fill with sand and seal vaults, areas, coal-holes, tunnels, trap doors or other openings located in public right-of-way adjacent to and having served the buildings being demolished. Owners of public or private utility systems still in use in vaults, areaways, coal-holes, tunnels, trapdoors or other openings will be responsible for moving or protecting same. This does not include utility vaults currently maintained by utility companies in the adjacent right-of-way area.

B. Remove on-grade slabs and those slabs up to 3 feet below grade. Treat slabs that are more than 3 feet below grade as basement slabs; they shall remain if not under new building or paved surfaces; however, break such slabs into distinct pieces which cover no more than 1 square yard apiece.

C. Remove other building walls, including interior foundation walls, partition walls, columns, piers, beams or other projections, to level of basement floor.

D. Remove driveways, sidewalks, slabs, entrances, private pools, patios, porch slabs, steps, retaining walls, , fences, signs, railings, bituminous surfacing and miscellaneous concrete within construction limits. This does not apply to sidewalks, driveways or signs within street rights-of-way except where specifically noted.

E. Remove supporting pads for storage tanks, fences, tanks and walls.

F. Perform other incidental and collateral work necessary to fully complete removal of building or buildings as specified.

3.4 DISPOSAL OF DEMOLISHED MATERIALS

A. As it accumulates, remove from site debris, rubbish, and other materials resulting from demolition operations. Storage or sale of removed materials will not be permitted at site.

B. Dispose of demolished materials off site at a permitted disposal facility, at no cost to Owner.

END OF SECTION

SECTION 024119
SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of site elements.
   3. Salvage of existing items to be reused or recycled.

B. Related Sections:
   1. Section 017329 – Cutting and Patching.

1.2 DEFINITIONS

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

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

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

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

1.3 SUBMITTALS

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

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

1.4 QUALITY ASSURANCE

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

B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

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

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

E. Pre-Demolition Conference: Conduct conference at Project site to review methods and procedures related to selective demolition including, but not limited to, the following:
   1. Inspect and discuss condition of construction to be selectively demolished.

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

1.5 PROJECT CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
   1. Comply with requirements specified in Division 1 Section "Summary."

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

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

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

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

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

1.6 WARRANTY

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

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

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

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

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

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

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

1. Comply with requirements for existing services/systems interruptions specified in Division 1 Section "Summary."

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
   2. Arrange to shut off indicated utilities with utility companies.
   3. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
   4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
      a. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

3.3 PREPARATION

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

B. Demolition work within existing spaces: Employ construction practices during demolition to minimize the production of dust, such as wet cutting of concrete slabs, masonry and water misting of rubble. Contractor to use anti-dust compounds when sweeping.

C. 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. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
   3. Cover and protect furniture, furnishings, and equipment that have not been removed.

D. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
   1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. 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 structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

7. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
8. Dispose of demolished items and materials promptly.

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

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

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. 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. Neatly trim openings to dimensions indicated.

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

C. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

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

B. Burning: Do not burn demolished materials.

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

3.7 CLEANING

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

END OF SECTION

SECTION 033001
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cast-in-place concrete, cement, aggregates, water and admixtures.
   2. Proportioning, mixing, conveying, placing, finishing, curing, and testing of cast-in-place concrete.
   3. Reinforcing bars, diamond plate dowels, welded steel wire fabric, and reinforcement ties and supports for cast-in-place concrete.
   4. Concrete formwork.
   5. Concrete accessories for cast-in-place concrete.
   6. Coordinate installation of items furnished and installed under other sections.

B. Related Sections:
   1. Section 053100 – Steel Decking.
   2. Section 079000 - Joint Protection.

1.2 REFERENCES

A. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials

B. ACI 214 - Recommended Practice for Evaluation of Strength Test Results of Concrete.

C. ACI 301 - Specifications for Structural Concrete for Buildings.

D. ACI 304 - Guide for Measuring, Mixing, Transporting and Placing Concrete.

E. ACI 305 - Hot Weather Concreting.

F. ACI 306 - Cold Weather Concreting.

G. ACI 309 - Guide for Consolidation of Concrete.

H. ACI 315 - Standards on Details and Detailing of Concrete Reinforcement.

I. ACI 318 - Building Code Requirements for Structural Concrete.

J. ACI 347 - Guide to Formwork for Concrete.

K. CRSI - Manual of Standard Practice.

L. CRSI - Placing Reinforcing Bars.

M. PS1 - Construction and Industrial Plywood.

N. Non-composite Steel Form Deck:
   1. Specifications for Design of Cold-Formed Steel Structural Members published by American Iron and Steel Institute (AISI).
   2. Steel Deck Institute Design Manual.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings, prepared by or under the supervision of a qualified professional engineer, in accordance with Section 013300 and the provisions of this Section.
   1. Formwork: Design and engineering of formwork are Contractor's responsibility.
      a. Show layout of non-composite steel form deck, accessories provided and information for proper installation. Pay attention to the need for adequate bearing including the effects of tolerances. Include name of deck manufacturer, type, depth, and gauge of non-composite steel form deck, and finish.
   2. Reinforcement: Prepare in accordance with ACI 315, "Details and Detailing of Concrete Reinforcement".

a. List and mark bars showing quantities, sizes, lengths, spacing, locations, bending details, schedules and ASTM designations.
b. Show locations, type and quantities of bolsters, spacers, chairs, support bars and other accessories.
c. Show concrete cover dimension from face of form to reinforcing bars.

B. Concrete Mix Designs: Submit mix design for each type and strength of concrete. Proportion designs in accordance with "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318.
1. Each mix design shall contain the following information:
a. Mix number (which will correspond to mix ticket on trucks delivered to site) and location of concrete on project.
b. Applicable mix specifications including:
1) Design strength.
2) Slump.
3) Air content.
4) Unit weight.
c. Mix ingredients including quantities, ASTM designations, and sources for:
1) Cementitious materials including fly ash.
2) Aggregates.
3) Water.
(a) Indicate amounts of mix water to be withheld for later addition at Project Site.
4) Admixtures (including manufacturer).
d. Preconstruction Test results:
1) Compressive strength results of trial batches or historical test data.
2) Statistical computations showing required average strength of mix.
3) Aggregate property results for exterior horizontal concrete in accordance with this Section.
4) Combined aggregate gradation as indicated for slab-on-grade mixes.
5) Unit weight.
6) Slump.
7) Water/cementitious ratio of mix.
8) Air content.
2. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Certificates: Signed by manufacturers certifying that materials comply with Project requirements.
1. Submit certificates of compatibility for all products with other products of this section or other sections where products will be in contact.

D. Product Data: Manufacturer's specifications and technical data including performance, construction and fabrication information.

1.4 QUALITY ASSURANCE

A. Formwork Tolerances: Design, construct and maintain formwork to insure completed work within tolerance limits specified in ACI 301 and ACI 347, unless more stringent tolerances are given in this specification, with stipulation that no tolerances specified for horizontal or vertical building lines or footings should be construed to permit encroachment beyond legal boundaries.

B. Manufacturer Qualifications: Use plant mixed concrete mixed in stationary mixers.
1. Truck mixed concrete is allowed provided procedures in ASTM C 94 are followed and documented.
2. Mix and deliver concrete in accordance with ASTM C 94.

C. Installer Qualifications:
1. Perform concrete reinforcing work in accordance with Concrete Reinforcing Steel Institute's recommended practices.
2. Perform concrete work in accordance with ACI 318, unless specified otherwise.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
   1. Allow specified inspector to observe reinforcing steel in place prior to pouring of concrete for each section.
   2. Do not pour concrete until deficiencies noted by specified inspector have been corrected.
   3. Notify specified inspector sufficiently in advance of scheduled time for pouring of concrete to allow observation to be made and corrections or adjustments completed, where required.

E. Source Limitations: Obtain materials from same source throughout Work.

1.5 DELIVERY, STORAGE AND HANDLING

A. Reinforcing materials shall be new, free of rust, loose scale or other coating that would reduce or destroy bond.

B. Deliver reinforcement bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

C. Store reinforcement to prevent damage and accumulation of dirt or excessive rust.

D. Avoid damaging coatings on steel reinforcement.

PART 2 PRODUCTS

2.1 FORM-FACING MATERIALS

A. General: Provide formwork units with sufficient thickness and stiffness to resist plastic concrete loads without detrimental deformation.

B. Forms for Exposed Finish Concrete: Construct formwork for exposed concrete surfaces with form-facing panels that will provide continuous, true, and smooth exposed concrete surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings. Form corners with 3/4 inch by 3/4 inch chamfer strips, mitered at changes in direction.
   1. Exterior grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      a. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.

C. Forms for Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

D. Backing for Forms: Structurally sound lumber or metal frame, solid, straight and free of defects that may impair its strength.

2.2 ACCESSORIES FOR REMOVABLE FORMS

A. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, adequate to prevent form deflection, and to prevent spalling concrete surfaces upon removal.
   1. Provide ties so that portion remaining within concrete after removal of exterior parts is at least one inch from outer concrete surface.
   2. Spreader cones on ties shall not be larger than one inch in diameter.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compounds.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2.3 NONCOMPOSITE STEEL FORM DECK

A. Noncomposite Steel Form Deck: Provide In accordance with requirements of Section 053100.

2.4 REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Epoxy Coated Reinforcing Steel: ASTM A 775.

C. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn ASTM A 82 plain-steel wire into flat sheets, rolls are not permitted.

2.5 REINFORCEMENT ACCESSORIES

A. Wire Bar Type Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture according to CRSI's "Manual of Standard Practice".

B. Supports: For slabs-on-grade with steel reinforcement use supports with sand plates, precast concrete chairs, or horizontal runners where base materials will not support chair legs.

C. Plastic-Tipped or Stainless Steel Legs: For concrete surfaces exposed to view or weather where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports. Hot dip galvanized support accessories may be used against formed surfaces not exposed to view or to weather.

D. Plastic Chairs: Use plastic chairs with plastic sand plates over membrane waterproofing or underslab vapor barrier to prevent penetration of membrane or barrier.

E. Diamond Plate Dowels: Saw cut from ASTM A 36 hot rolled plate.
   1. Diamond Dowel™ by PNA, Inc.

F. Epoxy-Coated Supports and Tie Wire: For epoxy-coated reinforcement, use epoxy coated or other dielectric-polymer-coated wire bar supports.

G. Epoxy-Coated Steel Reinforcing Touch-up Coating: 3M Scotchkote 213PC or liquid, two-part, epoxy repair coating complying with ASTM A 775.

2.6 REINFORCEMENT FABRICATION

A. Fabricate steel reinforcement in accordance with ACI 315, CRSI's "Manual of Standard Practice" and accepted shop drawings.

B. Do not re-bend or straighten steel reinforcement except where specifically accepted.

2.7 UNDERSLAB VAPOR BARRIERS

A. Underslab Vapor Barrier (UVB-3): ASTM E 1745, Class A. Permeance of less than 0.01 perms before and after mandatory conditioning tests per ASTM E 1745, Sections 7.1.1 – 7.1.5.

1.	Minimum Thickness	ACI 302	15-mil
2.	Maximum Water Vapor Permeance	ASTM E 154	0.01 perms
3.	Minimum Tensile Strength	ASTM E 154	45 lbf/in.
4.	Puncture Resistance	ASTM D 1709	2200 grams

   5. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Epro Services: Ecoshield E15
      b. Raven Industries: VaporBlock VB15.
      c. Reef Industries: Vaporguard.
      d. Stego Industries: Stego Wrap 15 mil.
      e. Viper: VaporCheck 16 mil.
      f. W.R. Meadows: Perminator 15 mil.

B. Accessories
   1. Seam Tape at Underslab Vapor Barrier:
      a. Manufacturer's recommended high density polyethylene tape with pressure sensitive adhesive. Minimum width 4 inches.
      b. Permeance less than 0.3 perms per ASTM F 1249 or ASTM E 96.
   2. Pipe Boots for Underslab Vapor Barrier:

a. Construct pipe boots from vapor barrier material and pressure sensitive tape per manufacturer's instructions.

2.8 EXPANSION JOINT FILLERS

A. Expansion Joint Fillers (Non-Sealed): Resilient non-extruding premolded bituminous impregnated fiberboard complying with ASTM D 1751.

1. Acceptable Manufacturers:
   a. Brock-White.
   b. North Central Construction Supply.
   c. W.R. Meadows.

B. Expansion Joint Fillers (Backing for Sealant): Flexible, compressible, closed-cell polyethylene foam, not less than 10 psi compression deflection.

2.9 FLOOR AND SLAB TREATMENTS

A. Penetrating Liquid Floor Treatment: Chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Penetrating Liquid Floor Treatment:
   a. Titan Hard; Burke Group, LLC (The).
   b. Day-Chem Sure Hard; Dayton Superior Corporation.
   c. Euco Diamond Hard; Euclid Chemical Co.
   d. Seal Hard; L&M Construction Chemicals, Inc.

2.10 INSERTS

A. Dowel Caps: Plastic material of size recommended for rod diameter.

2.11 CURING AND SEALING MATERIALS

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

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

1. Finishing Aid Concentrate; Burke Group, LLC (The).
2. Spray-Film; ChemMasters.
3. Aquafilm; Conspec Marketing & Manufacturing Co., Inc.
4. Sure Film; Dayton Superior Corporation.
5. Eucobar; Euclid Chemical Co.
6. E-Con; L&M Construction Chemicals, Inc.
7. Confilm; Master Builders, Inc.

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

D. Water: Potable.

E. Clear, Non-residual, Waterborne, Membrane-Forming Curing Compound (CS-1): Apply in accordance with manufacturer's recommendations and at coverage rate meeting ASTM C 309, Type 1, Class B, 18 to 22 percent solids. To be used at contractor's option in lieu of moist cure, in accordance with ACI 301, for floors to receive tile work, toppings, liquid applied waterproofing, synthetic flooring or other surface treatments for which bonding could be impaired by surface residue.

1. Klear Kote WB II 20 percent; Burke Chemicals.
2. Safe-Cure & Seal 20; ChemMasters.
3. Diamond Clear VOX; Euclid Chemical Co.
4. Dress & Seal WB; L&M Construction Chemicals, Inc.
5. Vocomp-20; W. R. Meadows, Inc.

6. Kure-N-Seal W; Sonneborn, Div. of ChemRex, Inc.
7. L&M Cure; L& M Construction Chemicals, Inc.
8. Sonneborn Kure-N-Seal W.; Chemrex, Inc.
9. 1100 Clear; W.R. Meadows.

F. Clear, Non-yellowing, Waterborne, Membrane-Forming Curing and Sealing Compound (CS-2): ASTM C 1315, Type 1, Class A, minimum 30 percent total solids. Comply with ACI 301, only for floors to remain bare or where surface treatments are compatible. Apply in accordance with manufacturer's recommendations. For floors to remain bare such as mechanical or utility rooms thoroughly clean surface and apply additional roller application just prior to project completion.

1. Klear-Kote Cure-Sealer-Hardener, 30 percent solids; Burke Group, LLC (The).
2. Polyseal WB; ChemMasters.
3. Lumiseal WB Plus; L&M Construction Chemicals, Inc.
4. Vocomp-30; W. R. Meadows, Inc.
5. Sonneborn Kure-N-Seal #30; Chemrex, Inc.
6. Master Kure; Master Builders.
7. Dress & Seal #30; L&M Construction Chemicals, Inc.
8. Super Rez-Seal; Euclid Chemical Co.

2.12 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I, corresponding to cement on which selection of concrete proportions was based. Use same brand for each required type of concrete.

B. Normal Weight Concrete Aggregates: (Excluding exterior horizontal concrete) ASTM C 33, uniformly graded. Do not use aggregates containing soluble salts or other substances which can cause stains on exposed surfaces. Use aggregates from one source of supply corresponding to that on which selection of concrete proportions was based.

C. Aggregates for Exterior Horizontal Concrete: Limits of deleterious substances and physical property requirements of fine and coarse aggregates shall comply with ASTM C33 and following additional requirements for exterior horizontal concrete:

1. Amount of deleterious substances in fine aggregate shall not exceed following limits:

Item	Weight Percent of Total Sample Maximum
Clay lumps and friable particles	0.5
Material finer than No. 200 sieve	3.0
Coal, lignite and shale	0.5

2. When fine aggregate is tested for potential reactivity by chemical method in accordance with ASTM C289, relationship between quantity Rc (reduction in alkalinity) and quantity Sc (dissolved silica) shall indicate that material is innocuous.
3. Coarse aggregate for exterior horizontal concrete (other than toppings less than 2 inch in thickness) shall be size number 67 (3/4 inch to No. 4) and shall be 100 percent crushed quarry rock composed of basalt, quartzite, granite, limestone or dolomite. For toppings less than 2 inch in thickness use size number 8.
4. When subjected to 5 cycles of soundness test using magnesium sulfate in accordance with ASTM C88, aggregate shall have loss of not more than 18 percent.
5. Coarse aggregate shall have maximum abrasion loss of 40 percent by weight when tested in accordance with ASTM C131, Grading B.
6. Requirements of ASTM C33, Table 3, as to amount of material in coarse aggregate having specific gravity lighter than 2.4 shall include iron oxide.

D. Maximum size of coarse aggregates for normal weight concrete shall comply with ACI 301, but shall not be larger than 1-1/2 inch for footings, 1 inch for slabs-on-grade, and 3/4 inch for slabs.

E. Water: ASTM C 94. Fresh, clean, potable, free from injurious amounts of oils, acids, alkalies, salts, organic materials, or other substances that may be deleterious to concrete or steel.

2.13 SUPPLEMENTARY CEMENTING MATERIALS

A. General: The following materials shall be incorporated into the Work as specified or at Contractors option within the limitations set forth.

B. Fly Ash Admixture: ASTM C 618, Class C or F; Loss of Ignition (LOI) less than 1 percent. Addition of fly ash to regular weight and lightweight concrete mixes to reduce amount of cement is permissible as follows:

1. When used in exposed concrete it shall be used throughout for uniform color.

C. Replacement Ratio: Portland cement shall be replaced on an equal mass (not weight) basis. The material replacements shall be expressed as a percent, by mass, of the total cementitious materials content, with proportions selected for 28 day compressive strengths equal to those specified. The change in volume resulting from the substitutions shall be determined and an adjustment in both coarse and fine aggregate proportions shall be determined in order to ensure a unit volume.

1. Fly Ash replacement shall not exceed 25% for Class C, 15% for Class F, or as specified for a particular mix design.

D. Water-Cementitious Materials Ratio: The full mass of the total cementitious materials shall be included in the denominator for the water-cementitious materials ratio (w/c) calculation.

2.14 ADMIXTURES

A. General: Admixtures shall be certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride or thiocyanates.

B. Manufacturers: Subject to compliance with the requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the those listed below.

C. Air-Entraining Admixtures: ASTM C 260.

1. Euclid Chemical Company: Air-Mix.
2. General Resource Technology: Polychem AE.
3. Grace Construction Products: Daravair series or Darex series.
4. Master Builders: Micro-Air.
5. Protex Industries: Protex AES.

D. Water Reducing Admixtures: ASTM C 494, Type A.

1. Euclid Chemical Company: Eucon WR-75.
2. General Resource Technology: Polychem 1000.
3. Grace Construction Products: WRDA.
4. Master Builders: Pozzolith 220N.

E. Mid-Range Water-Reducing Admixtures: ASTM C 494, Type A.

1. Euclid Chemical Company: Eucon A+.
2. General Resource Technology: KB-1000.
3. Grace Construction Products: Daracem-65.
4. Master Builders: Polyheed.

F. High-Range Water Reducing Admixture (Superplasticizer): ASTM C 494, Type F or G.

1. Euclid Chemical Company: Eucon 37.
2. General Resource Technology: Melchem.
3. Grace Construction Products: ADVA 100 or Daracem 100.
4. Master Builders: Conchem SPN 11.

G. Water Reducing and Retarding Admixture: ASTM C 494, Type D.

1. Euclid Chemical Company: Eucon Retarder-75.
2. General Resource Technology: Polychem R.
3. Grace Construction Products: Daratard 17.
4. Master Builders: Pozzolith 100XR.

H. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E,

1. Euclid Chemical Company: Accelguard 80.

2. General Resource Technology: Polychem Super Set.
3. Grace Construction Products: Polarset.
4. Master Builders: Pozzolith NC 534.

I. Prohibited Admixtures: Calcium chloride, thiocyanates or admixtures effectively containing chloride ions (more than 0.05 percent) are not permitted.

2.15 GROUT

A. Epoxy Grout:

1. Sika Dur Hi Mod by Sika Chemical.
2. HSE 2411 by Hilti.
3. Ceramic 6 by Epcon.

2.16 NORMAL WEIGHT CONCRETE MIXES

A. General: Manufacture and deliver concrete in accordance with ASTM C 94 with exceptions specified herein. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.

B. Minimum Compressive Strength: As indicated on the Drawings.

C. Air Entrainment: Exterior exposed concrete shall contain 6 percent entrained air with maximum tolerance of plus or minus 1.5 percent.

D. Maximum Slump: 4 inches without super-plasticizer, 7 inches after addition of super-plasticizer. A tolerance of up to one inch above indicated maximum will be allowed for one batch in any five consecutive batches tested. Slump shall be determined by "Test for Slump of Hydraulic Cement Concrete" (ASTM C143) at point of placement. If the maximum water-cement ratio is not exceeded, concrete arriving at the jobsite within 60 minutes of the initial batching that has a slump less than the maximum allowed may have water added when accepted by the project inspector. A super-plasticizer may be added to increase the slump when water can not be added and additional slump is necessary for workability when accepted by the project inspector. Water shall not be added to the mix after any supplemental water reducing admixtures added at the jobsite.

2.17 SLAB-ON-GRADE CONCRETE MIXES

A. Concrete mix design requirements for building area slabs-on-grade:

Item	
Compressive Strength at 28 days (min), f'_c	4000 psi
Maximum water/cementitious materials ratio, w/cm	0.45
Cementitious Materials Content	500-540 lbs/yd^3
Cementitious Materials Portland Cement – ASTM C 150, Type I Fly Ash – ASTM C 618, Class C or F, LOI < 1%	 75% - 85% 15% - 25%
Top-size Aggregate	1-1/2 inch
Aggregate Gradations	Well graded aggregate as specified.
Air Entraining Admixture, (AEA)	None.
Water Reducing Admixture, (WR), ASTM C 494, Type A	As necessary to bring slump up to maximum 5-inches within manufacturer's limits.
Polycarboxylate High-Range Water Reducing Admixture, (HRWR), ASTM C 494, Type F	As necessary to further increase slump for additional workability up to maximum 7-inches within manufacturer's limits.

B. Slab-on-Grade Aggregate Gradation: Combined aggregates shall be well graded from the coarsest to the finest with not more than 18 percent nor less than 8 percent, unless otherwise permitted, of the combined aggregate retained on any individual sieve with the exceptions that the No. 50 may have less than 8 percent retained, sieves finer than the No. 50 shall have less than 8 percent retained, and the coarsest sieve may have less than 8 percent retained.

1. A maximum of two sieves between 1” and No. 50 may fall outside the prescribed limits above with a maximum 22% retained and a minimum 5% retained on these nonconforming sieves.

C. Addition of water on jobsite to concrete mix is prohibited.

PART 3 EXECUTION

3.1 FORMWORK DESIGN

A. Removable Forms: Design for vertical and lateral loads and pressures outlined in the ACI Standard "Guide to Formwork for Concrete" (ACI 347). Contractor shall be solely responsible for the design, engineering, construction, maintenance, completeness, safety, and adequacy of all removable formwork.

B. Tolerances: Design removable forms to insure completed work within allowable tolerances of ACI 117 or those specified.

C. Surface Irregularities: Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   1. Class A, 1/8 inch – Surfaces prominently exposed to public view
   2. Class B, 1/4 inch – Surfaces to receive plaster, stucco, or wainscoting.
   3. Class C, 1/2 inch – General conditions.
   4. Class D, 1 inch – Foundations permanently concealed to view.

D. Openings: Design formwork with temporary openings at locations as required for inspections and to permit removal of extraneous materials before placing concrete.

E. Removal: Design forms for safety in removal without damage to concrete.

F. Joints: Design with minimum number of joints and with joints sufficiently tight to prevent leakage of grout or cement paste.

3.2 ERECTION OF REMOVABLE FORMS

A. Verify lines, levels, measurements, elevation and center locations before proceeding with formwork.

B. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts and other features required.

C. Construct forms of materials selected to obtain required finishes.

D. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.

E. Kerf wood inserts used for forming keyways, recesses, and similar features to prevent swelling and assure ease of removal.

F. Locate temporary openings in forms as inconspicuous as possible, consistent with project requirements. Brace closures and set tightly to forms to prevent loss of concrete mortar.

G. Provide permanent openings in forms where shown or required to accommodate other work, including Mechanical and Electrical Work.

H. Erect and support, brace and maintain formwork and falsework to safely support vertical, lateral, and asymmetrical loads and forces until they can be supported by in- place concrete structures.

I. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surfaces. Provide and secure units to support types of screeds required.

J. At intersecting planes provide sharp, clean corners without visible edges or offsets and back joints with extra studs or girts to maintain true, square intersections.

K. At changes in plane, form molding shapes, recesses and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

L. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris before concrete is placed. During cold weather be sure that ice and snow has been removed.

M. Retighten forms, if necessary, immediately after concrete is placed to eliminate mortar leaks. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflections or signs of possible failure and make necessary adjustments to produce work of required dimensions.

N. Do not displace or damage vapor barrier.

3.3 EMBEDDED ITEMS

A. Accurately place and securely support items required to be built into forms. Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.

B. Install anchor bolts, accurately located, to elevations required.

3.4 ERECTION OF NONCOMPOSITE STEEL FORM DECK

A. Place sheets with edges up and flutes at right angles to supports.

B. Lap ends minimum of 2 inch with centers of laps located at centers of supports.

C. Lap sheets one-half flute at side laps.

D. Fastening to Supporting Members: Permanently fasten deck units to steel end, intermediate, and edge supports with fully fused arc spot (puddle) welds or arc seam welds, penetrating layers of decking as follows:

1. Weld Size: Arc spot (puddle) welds shall have fusion areas to supporting members not less than 5/8 inch diameter in size. Arc seam welds shall have fusion areas to supporting members not less than 3/8 inch by 1 1/2 inches long.
2. Weld Spacing: As noted on drawings.

E. Side-Lap Fastening: Fasten side laps as noted on drawings.

1. Mechanically fasten with self-drilling No. 12 diameter or larger carbon-steel screws.
2. If deck has interlocking side laps, fastenings may be button punched or mechanically clinched.
3. If deck is 18 gauge or heavier, fastenings may be welded with a minimum 1 1/2 inch long welds.

F. If factory formed side lap vents are not provided, install 1 vent clip at midspan of each sheet side lap between supports.

G. Perform welding by competent, experienced welders.

3.5 APPLICATION OF FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's instructions. Do not allow excess form release agent to accumulate in forms or come into contact with surfaces which will be bonded to fresh concrete. Apply prior to placing reinforcing steel, anchoring devices, and embedded items.

B. Do not apply form release agent where concrete surfaces are scheduled to receive special finishes or applied coverings which may be affected by agent. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

3.6 FORM REMOVAL AND REUSE

A. Do not remove forms, shores and bracing until concrete has gained sufficient strength to carry its own weight, construction live loads, and lateral loads which are liable to be imposed upon them without damage, overstress, or excessive deflection.

B. Remove formwork progressively and in accordance with code requirements so that no shock loads or unbalanced loads are imposed on structure.

C. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against concrete surfaces. Repair or replace, as directed, all damaged work.

D. Store removed forms used for exposed concrete in manner that surfaces to be in contact with fresh concrete will not be damaged. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for reuse on exposed surfaces.

E. Forms not directly supporting weight of concrete may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete or as soon as stripping operations will not damage concrete.

3.7 REINFORCEMENT INSTALLATION

A. Underfloor Vapor Barriers: When chairing reinforcement on top of underfloor vapor barriers, use only plastic type reinforcing bar supports with sand plates, or provide 6 in x 6 in protective pads of asphaltic hardboard or other material recommended by the manufacturer. Do not displace or damage vapor barrier.

B. After installation of reinforcement (if used) but before pouring concrete, check for damage to underfloor vapor barrier. Repair any damage and reseal underslab vapor barrier before placing concrete.

C. Clean steel reinforcement to remove loose rust and mill scale, earth, ice and other foreign materials which will reduce or destroy bond with concrete.

D. Install concrete reinforcement in accordance with reviewed shop drawings and CRSI recommended practices.

E. Position, support, and secure steel reinforcement against displacement by formwork, construction, or concrete placement operations.

F. Locate and support steel reinforcing by metal bolsters, spacers, chairs and hangers to maintain specified concrete cover. Securely tie bars and supports together with 16 gauge wire to hold steel reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from concrete surfaces.

G. Provide bar supports in sufficient number and heavy enough to carry steel they support. Place no bar more than 2 inches beyond last leg of continuous bar support. Do not use bar supports to support runways for concrete buggies, or similar loads.

H. Steel reinforcement partially embedded in concrete shall not be field bent, except as indicated or permitted by Structural Engineer.

I. For walls reinforced on both faces, provide spreader bars and chairs to surfaces of forms on each side at spacings not to exceed 8 feet in either direction. For walls with single layer of reinforcing, provide chairs each side at spacings not to exceed 8 feet in either direction.

J. Splice bars only where shown or noted. Comply with requirements of ACI 318 for minimum lap of bars and stagger, unless noted otherwise

K. Install welded wire fabric in lengths as long as practical on bar supports spaced to minimize sagging. Offset end laps in adjacent sheets to prevent continuous laps in either direction. Lap edges and ends of adjoining sheets at least two mesh spacings. Lace overlaps with wire. Locate fabric as indicated on Drawings.

L. Install diamond plate dowels in concrete slab-on-grade joints where shown. Install diamond plate dowels per manufacturer's written instructions.

M. Exposed reinforcing steel after concrete has been placed, indicating steel is not properly located, will be sufficient cause for rejection, removal and replacement of concrete section.

N. Tack welding of reinforcing steel is prohibited. Reinforcement damaged by arc strikes or welding shall be replaced.

O. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963.

3.8 INSTALLATION OF UNDERFLOOR VAPOR BARRIERS

A. Place underfloor vapor barrier directly below all building slabs-on-grade per drawings.

B. Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.

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

D. Verify that sleeves, ties, and other penetrating components which pass through surfaces to receive barrier are rigidly installed.

E. Clean substrates of substances harmful to vapor barriers, including removing projections capable of puncturing vapor barriers.

F. Place, protect, and repair vapor barrier sheets in accordance with manufacturer's instructions and ASTM E 1643.

1. Unroll vapor barrier with the longest dimension parallel with the direction of the pour.
2. Lap vapor barrier over footings and seal to foundation walls.
3. Overlap joints 6 inches and seal with pressure sensitive tape.
4. Seal penetrations including pipes, conduits, and ducts with pipe boots and pressure sensitive tape.
5. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities.
6. Terminate vapor barrier at walls with sealant.
7. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all four sides with pressure sensitive tape.

3.9 PLACING CONCRETE

A. Place concrete in accordance with ACI 301. Consolidate concrete in accordance with ACI 309 using high frequency vibrators.

B. Clean forms, reinforcing and accessories and dampen forms immediately prior to placing concrete.

C. Schedule concrete deliveries to ensure that concrete in each load is placed within 90 minutes after mixing water is added.

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

E. Deposit concrete as near as practicable to its final position to avoid segregation due to rehandling or flowing, in layers not exceeding 18 inch in depth. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness.

1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
3. Do not insert vibrators to bottom of slabs-on-grade with underfloor vapor barriers to avoid damaging this membrane.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations

G. Do not allow concrete to fall freely more than 5 feet. Use tremies, chutes or elephant trunks where necessary.

H. Do not use concrete that has partially hardened or been contaminated by foreign materials, nor concrete that has been retempered or remixed after initial set.

I. Before depositing new concrete on or against concrete that has set at construction joints, clean, wet and apply neat cement slurry to existing surfaces. Tighten forms prior to resuming pouring.

J. Exercise care to prevent splashing of forms or reinforcing with concrete above level of concrete being placed.

K. Clean reinforcement projecting above or out of concrete immediately after completion of particular unit of pour.

L. Do not place concrete under adverse weather conditions unless adequate protection is provided. Refer to ACI 301, for weather restrictions and placing temperatures.

3.10 COLD WEATHER CONCRETING

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
4. Ensure minimum temperatures are maintained for the duration of the curing period in accordance with ACI 306.1.

3.11 HOT WEATHER CONCRETING

A. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. When temperature of steel reinforcement, embeds, subgrade, or forms is greater than 120 degrees F, fog-spray forms, steel reinforcement, embeds, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
3. Dispatch transport trucks to avoid delays and organize work to use concrete promptly.
4. Protect concrete from wind and direct sunlight to avoid rapid drying. Apply evaporation retarder, curing compounds, and moisture retaining covers in accordance with concrete curing and protection methods as specified.

3.12 CONSTRUCTION, CONTRACTION AND EXPANSION JOINTS

A. Provide construction joints when stoppage of concreting operations occurs.

B. Continue reinforcing steel across construction joints unless noted or detailed otherwise.

C. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
   1. Unless detailed otherwise, locate horizontal construction joints in walls and columns at underside of floor slabs and beams.

D. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Where contraction joint spacings are not specifically shown they shall be spaced approximately 15 feet on centers at interior locations where joints will be exposed or under non-resilient floor covering. At interior locations below resilient finish or carpet spacings may be increased to approximately 30 feet. Interior panels shall be near-square with short: long side ratio not less than 2:3. At exterior locations spacings of contraction joints shall not exceed 10 feet on centers and short-long side ratio shall not be less than 3:4. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
   1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Sawcut joints in concrete slabs-on-grade as soon as the slab will support the weight of the saw and operator without disturbing the final finish. Sawcutting can normally occur from 0 to 2 hours after final finishing. Cut 1/8 inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
   2. Provide very lightly rounded edges at construction, control and expansion joints where slab joint will be exposed.
   3. Where sawcut control joints in exterior slabs-on-grade are shown, provide in accordance with ACI 301, 1/4 depth of slabs unless shown otherwise. Cut joints to their full depth as soon as condition of concrete will permit, in 2 or more passes, with first pass cut 1/2 inch deep.

E. Provide vertical construction, control, and expansion joints in walls as detailed. Pour sections alternately with minimum waiting period of 48 hours between adjacent pours. Unless noted otherwise, locate joints midway between columns. Do not locate joints within 5 feet of corner, wall intersection or pier. Unless noted otherwise locate vertical contraction joints in walls at 30 feet maximum spacing.

3.13 FINISHING FLOORS AND SLABS

A. Finish bare concrete floors (adjacent to floors with other surfacing) so concrete surface is level with other finishes, unless otherwise noted.

B. Grind smooth joints between slabs on grade and structural slabs and between existing and new surfaces just prior to installation of floor covering to eliminate unevenness and to provide smooth, level surface across joints.

C. Protect finished surfaces from damage. Keep free of abrasive materials.

D. Set screeds by instruments with firm, stable supports, but not mortar mounds. Place concrete to accurate screeds, with screed lines filled.

E. Start finishing when concrete has hardened sufficiently to permit use of mechanical rotary finisher. Finishing machines shall thoroughly compact and level concrete, using 2 to 4 passes of machine.

F. Follow with steel troweling when steel troweling is specified.

G. In areas where water will be present (interior and exterior) place and finish slabs so areas will drain and water will not stand in puddles. Conform to slopes shown. At structural slabs, verify elevations of drains to insure drains will be at low points. Where elevations and slopes are not indicated, generally slope floors 1/8 inch per foot uniformly to drains, unless otherwise directed by Architect.

H. Trowel Finish (CONC FIN-1): Apply a trowel finish to monolithic slab surfaces exposed to view, equipment pads, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
   1. After floating, begin first trowel-finish operation using a power-driven trowel.
   2. Begin final troweling when surface produces a ringing sound as trowel is moved over surface.

3. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F_F20 (floor flatness) and F_L18 (floor levelness) for slabs-on-grade and F_F20 for elevated slabs, measured according to ASTM E 1155.
4. Grind smooth any surface defects that would telegraph through applied floor covering system.

I. Nonslip Broom Finish (CONC FIN-2): Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

J. Float Finish (CONC FIN-6): Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.

1. After screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating.
2. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both.
3. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units.
4. Finish surfaces to tolerances of F_F18 (floor flatness) and F_L18 (floor levelness) for slabs-on-grade and F_F18 for elevated slabs, measured according to ASTM E 1155. Cut down high spots and fill low spots.
5. Uniformly slope surfaces to drains.
6. Immediately after leveling, refloat surface to uniform, smooth, granular texture.

K. Broom Finish (CONC FIN-10): At parking ramp and drive areas.

1. Bull float immediately after screeding. Complete before any excess moisture or bleed water is present on the surface.
2. After excess moisture or bleed water has disappeared and concrete has stiffened sufficiently to allow operation, give slab surfaces coarse transverse scored texture by drawing broom across surface. Texture shall be as accepted by the Architect from sample panels.
3. Finish Tolerance: Surface shall not vary by more than ±3/4 inches anywhere from elevation noted on Drawings.
4. Contractor shall fabricate two acceptable test panels simulating finishing techniques and final appearance. Intent of test panels is to simulate both high and low workability mixes, with slumps at time of casting to be 6 inches and 3 inches, respectively. Test panels shall be minimum of 20 feet by 30 feet and use approved mix designs. Accepted test panels may be incorporated into the finished construction.
5. Finish all concrete slabs to proper elevations to insure that all surface moisture will drain freely, and that no puddles exist. Contractor shall bear cost of any corrections to provide positive drainage.

3.14 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.

1. Typical unless indicated otherwise.

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

3.15 MISCELLANEOUS CONCRETE ITEMS

A. Provide miscellaneous concrete items as noted and detailed on Drawings.

B. Provide and install reinforcing, anchors and bolts in concrete where directed and required.

C. Provide for installation of inserts, hangers, metal ties and other fastening devices required for attachment of other work.

D. Properly locate fastening devices in cooperation with other trades and secure in position before concrete is placed.

3.16 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Provide curing and protection immediately after placement in accordance with ACI 301.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if the air temperature exceeds 80 degrees F, the wind speed exceeds 10 mph, or the relative humidity is less than 40%. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms are removed during curing period, immediately employ one of curing materials or methods specified for concrete surfaces not covered by forms and continue for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with no dryouts with the following materials:
    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12 inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days with no dryouts. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    b. Moisture cure or use moisture-retaining covers on all surfaces if temperature conditions exceed 90 degrees.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    a. Cure concrete surfaces to receive floor coverings with either a curing compound or moisture-retaining cover that the manufacturer recommends for use with floor coverings. Any deleterious residual material that might affect performance of floor covering shall be cleaned from surface prior to placement of floor covering.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.17 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than seven days old.

3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.18 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas as determined by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval and in accordance with ACI 301. Repair methods for defects affecting the concrete's structural performance shall be closely coordinated between Contractor and Engineer.

B. Patching Material: Contractor shall submit proposed patching materials for Architect's review and approval.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. After form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching material before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching material will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects and fill tie holes on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching material. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching material before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval

3.19 FIELD QUALITY CONTROL

A. Reinforcement inspection shall be performed by an ACI Certified Grade 1 inspector, who shall be under the direct supervision of a Professional Civil or Structural Engineer registered in the State of Wisconsin.

B. Inspect all reinforcing steel in cast-in-place concrete as follows:
   1. Verify size, quantities and grade of reinforcing steel.
   2. Verify placement of reinforcing steel is complete.
   3. Verify that bars are accurately placed, tied and clean.
   4. Verify bar laps for proper length and bar bends for minimum diameter, slope and length.

C. Coordinate with ITL employed by the Owner to make, cure and determine strength of concrete test cylinders cast in field. Perform in accordance with ASTM C172 - Practice for Sampling Freshly Mixed Concrete, ASTM C31 - Practice for Making and Curing Concrete Test Specimens in the Field and ASTM C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens. Evaluation and acceptance of concrete shall be in accordance with ACI 318 with following exceptions:
   1. Make one set of cylinders for each day's operation and each type of concrete where less than 50 cubic yards is placed, plus additional sets for each 100 cubic yards (or fraction thereof) over and above first 50 cubic yards of each type.
      a. Test sets shall consist of 4 cylinders with fourth cylinder to be field-cured specimen.
      b. For slabs placed when temperatures are expected to fall below 32 degrees F within 72 hours of placement, cast-in-place (pop out) cylinders shall be used.
      c. These cylinders shall be placed close to corners and perimeter of pour.
   2. Store field-cured cylinder as near as possible to location of concrete represented by sample and give cylinder, insofar as practicable, same protection and curing as adjacent concrete.
      a. Keep other 3 cylinders covered with plastic or wet burlap and in 60 - 80 degrees F temperature range for 24 hours, allowing no injury to cylinders.
      b. After this period, and prior to age of 48 hours, deliver 3 cylinders to laboratory for additional curing, taking care not to freeze, crack or damage specimens.
   3. Deliver field-cured cylinder to laboratory at 28 days of age for testing to check adequacy of curing and protection as described in ACI 318.
   4. Test other 3 cylinders, laboratory cured, as follows: One at 7 days of age for projecting probable 28 day strength and 2 cylinders at 28 days for acceptance of average strength as described in ACI 318.
   5. If additional field cured specimens are required to verify early strength of concrete, contractor shall pay for additional testing.

D. Determine slump of concrete in accordance with ASTM C143 - Test Method for Slump of Hydraulic Cement Concrete. Perform one test for each set of test cylinders.

E. Determine air content of fresh concrete, when air content is specified, in accordance with ASTM C173 or ASTM C231. Where placement is by pump, air content shall be measured at location of placement. For concrete exposed to freezing and thawing, concrete from each truck shall be tested and concrete not meeting specified percentages shall not be placed. For interior concrete not exposed to freezing and thawing, such as lightweight concrete on metal decking, perform one test for each set of test cylinders. Concrete used in performing air content test shall not be used in fabricating test specimens.

F. Test concrete temperature hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and each time a set of test cylinders is made.

G. Mark each test cylinder with job name, Contractor's name, mix number, date, location of pour and measured slump. In addition, mark measured air content when air-entraining admixture is specified.

H. ITL shall submit copies of test results to Owner, Architect and Contractor as soon as practicable after they are made.

3.20 EVALUATION OF TEST RESULTS AND FAILURE TO MEET STRENGTH REQUIREMENTS

A. Test results: Evaluate in accordance with ACI 214.

B. Evaluations shall be valid only if samples have been taken and tests have been conducted in accordance with ACI and ASTM specifications and methods as applicable.

C. If strength tests performed on concrete cylinders, cast at time concrete is placed, fail to meet specified 28 day values, or if samples have not been taken and tests conducted as specified, concrete represented by such samples and tests shall be considered questionable and shall be subject to further testing at expense of Contractor.

D. These additional tests of questionable concrete shall be performed by Independent Testing Laboratory, acceptable to Architect, and shall be conducted in accordance with ASTM C42. Concrete cores may be obtained in field, or load tests conducted and results evaluated in accordance with ACI 318.

E. Test results obtained by use of impact hammer or sonoscope, unless correlated with other data, will not be considered conclusive in evaluating strengths of concrete.

F. If additional testing fails to demonstrate strengths adequate for intended purpose of member or members in question, as determined by Architect, remove questionable concrete and replace with concrete meeting specifications.

END OF SECTION

SECTION 042001
UNIT MASONRY AND RELATED MATERIALS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete masonry units (CMU).
   2. Joint reinforcement, anchorage, and accessories.
   3. Reinforcing bars and deformed bar anchors in unit masonry.
   4. Installation of anchor bolts and other embedments in unit masonry.

B. Related Sections:
   1. Section 033000 - Cast-in-Place Concrete.
   2. Section 051200 - Structural Steel: Items to be built in masonry work.
   3. Section 055000 - Metal Fabrications: Items to be built in masonry work.
   4. Section 079000 - Joint Protection: Sealants for expansion/contraction joints.

1.2 REFERENCES

A. ANSI A41.1 - Building Code Requirements for Masonry.

B. ACI 530.1/ASCE 6 - Specifications for Masonry Structures.

1.3 SUBMITTALS

A. Product Data and Test Reports: Submit manufacturer's recommendations, product data and test reports in accordance with this section and Section 013300.

B. Samples: Submit samples of face brick unit masonry for color verification and appearance acceptance.

1.4 QUALITY ASSURANCE

A. Reference Standards: Comply with requirements of listed standards unless indicated otherwise.

B. Fire Rated Masonry: Whenever fire-resistance classification is shown or scheduled for unit masonry construction, comply with requirements for materials and installation established by governing authorities for construction shown.

C. Test Data: Provide evidence and test data confirming that concrete block and brick conform to standards.

D. Mortar Mixes: Comply with ASTM C270. Mortar for exterior use and for load bearing masonry shall conform to Table 2 property specification requirements. Mortar for other uses may be proportion specification or property specification at Contractor's option.

E. Testing of mortar mix will be performed by testing laboratory and approved by Architect, in accordance with Section 014500.
   1. Tests paid for by Contractor.

F. Submit proposed mortar mix design in accordance with ASTM C270 to testing laboratory for approval prior to commencement of work. Use representative samples of mortar materials and proportions to be utilized in construction.

G. Preconstruction Testing of Mortar Mix
   1. Perform testing of mortar mix to ensure conformance with requirements stated herein and to ensure mortar will not produce efflorescence.
   2. Bond Strength Test: As recommended by testing laboratory, adjust face brick mortar proportions by volume to achieve minimum bond strength of 20 psi.

3. Progress Tests: Provide two 3 inch by 6 inch mortar cylinders on first 10,000 masonry units laid or first 2 weeks of masonry work, whichever occurs first. Thereafter, if tests are acceptable, provide 2 test cylinders for each 50,000 masonry units or every 4 weeks, whichever occurs first. For each series, test mortar samples in accordance with ASTM C780 for compressive strength.
4. If mortar mix does not conform with requirements stated herein, re-establish and resubmit for further testing. Costs for required retesting paid by Contractor.

H. Preconstruction Testing of Concrete Masonry Units:
1. Tentative Acceptance: For tentative acceptance of blocks provide tests and reports on minimum of 5 units, from current stock, to provide proof of ability to conform to ASTM Standards. Texture, dimension, tolerance, appearance and test reports will be basis for tentative acceptance of supplier of blocks. Provide samples to Architect for appearance approval.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Maintain materials and surrounding air temperature to minimum 50 degree F prior to, during and 48 hours after completion of masonry work.

B. Do not use metal reinforcing or ties having loose rust or other coatings including ice, which will reduce or destroy bond.

C. During freezing or near freezing weather, provide adequate equipment or cover to maintain minimum temperature of 50 degree F and to protect masonry work completed or in progress. Conform to other requirements stated in Division 1.

D. Frozen Materials: Do not use frozen materials or materials mixed or coated with ice or frost. For masonry which is to be wetted, comply with BIA recommendations. Remove and replace masonry work damaged by freezing.

1.6 PROTECTION

A. Maintain protective boards at exposed external corners which may be damaged by construction activities. Provide such protection without damaging completed work.

B. Keep cavities and expansion and expansion-contraction joint voids clear of mortar.

C. Provide temporary bracing during masonry erection. Maintain in place until building structure provides permanent bracing.

D. Protect block walls from excessive moisture after laying. Cover tops of walls when work is not in progress.

E. Heat materials and provide temporary protection of completed portions of masonry work. Comply with governing codes and with "Construction and Protection Recommendations for Cold Weather Masonry Construction" of Technical Notes or Brick and Tile Construction by Brick Institute of America (BIA). Extend covering at least 2 feet down both sides of walls and hold securely in place.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Concrete Blocks: Modular size, load bearing, ASTM C90.
1. (CMU-1) Normal weight Class 1: C33 Aggregate. Unless concrete block is indicated as "light weight block", provide normal weight concrete block.
a. Size:
1) Nominal, as indicated.

B. Provide shapes indicated and as follows:
1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners, unless indicated as bullnose.

C. Curing: Kiln and air cured under cover until age of blocks is at least 45 days. Autoclave cured type block may be used.

D. Appearance Requirements: Units shall be light in color, with uniform fine texture, free of face smears.
   1. Broken units shall not be used and chipped or other defective units will not be acceptable or used where exposed. Not over 5 percent of units will be permitted to have chips and chips shall not exceed 3/8 inch in any dimension.
   2. Exposed concrete masonry unit walls shall have units uniform in size, texture and color. Architect reserves right to reject unit masonry manufacturer if, in Architect's opinion, unit quality, color or texture is unacceptable with design intent.
   3. Appearance requirements may be waived by Architect (at their option) for concealed units.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C150, Type I, non-staining without air-entrainment, and of natural color. Use Type III high early strength for laying masonry in cold weather.
   1. Use same brand of cement, lime and aggregate throughout project to insure uniform mortar colors.

B. Masonry Cement: Masonry cement not allowed.

C. Aggregates: ASTM C144 and C404.

D. Hydrated Lime: ASTM C207 Type S, without air-entrainment.

E. Premix Mortar: Commercially prepared premix of low alkali Portland cement, hydrated lime, and aggregates; ASTM C387; mortar Type M, S, N.
   1. Optional Mortar Cement (in lieu of Portland Cement and Lime); Lafarge Mortar Cement complying with Uniform Building Code for Mortar Cement. Use at Contractor's option.

F. Water: Potable.

2.3 MASONRY GROUT

A. Provide pea-gravel concrete conforming to ASTM C476, to fill bond beams, concrete unit masonry cells containing vertical reinforcing bars, and other cells or cavities where indicated.

B. Minimum compressive strength of grout shall be 3000 pounds per square inch at 28 days of age. Make, cure and determine strength of grout test prisms in accordance with ASTM C1019.

C. Add sufficient water to produce mix of suitable consistency for pouring without segregation. Slump range: 8 inches to 11 inches.

D. Use fine aggregate size No. 2 and coarse aggregate size No. 8 in accordance with ASTM C404.

2.4 REINFORCEMENT AND ANCHORAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Heckman Building Products.
   2. Dur-O-Wal Incorporated.
   3. Hohmann and Barnard Incorporated.
   4. AA Wire Products Co.

B. Deformed Reinforcing Bars for Wall Reinforcing: Steel Reinforcing Bars at Concrete Unit Masonry; ASTM A615, Grade 60, or comply with Section 032000.

C. (HORIZ REINF-1) Horizontal Reinforcing at Concrete Unit Masonry: Continuous Wire Joint Reinforcing with 9 gauge side rods and crossrods.
   1. Use hot dipped galvanized wire ASTM A 153, Class B-2 (1.5 oz. PSF) for exterior masonry walls.
   2. Use mill galvanized wire ASTM A641. Class 1 (0.40 minimum zinc coating) for interior masonry walls.
   3. Use prefabricated corners and tees at wall intersections.
   4. Acceptable Manufacturers:

a. Dur-O-Wal: Truss-type D/A 310.
b. Comparable product of other specified manufacturers.

D. (HORIZ REINF-2) Horizontal Reinforcing at Concrete Unit Masonry: Continuous Wire Joint Reinforcing with 9 gauge side rods and crossrods.
1. Use hot dipped galvanized wire ASTM A153, Class B-2 (1.5 oz. PSF) for exterior masonry walls and interior walls at moisture areas.
2. Use mill galvanized wire ASTM A641. Class 1 (0.40 minimum zinc coating) for interior masonry walls.
3. Use prefabricated corners and tees at wall intersections.
4. Acceptable Manufacturers:
a. Dur-O-Wal: Ladder-type D/A 3200.
b. Comparable product of other specified manufacturers.

E. (BT-1) Cavity Wall Ties At Concrete Block Backup Wall: Continuous truss reinforcement with rectangular wall ties at 16 inches o.c., Reinforcing with 9 gauge side rods and crossrods, and pintles
1. Hot dipped galvanized steel wire complying with ASTM A153, Class B-2 (1.5 oz PSF).
2. Acceptable Manufacturers:
a. Dur-O-Wal: DA3700 Dur-O-Eye Assembly with Adjustable Wall Pintle Sections
b. Comparable product of other specified manufacturers.

F. (BT-2) Ties at CMU to Brick Back-up: Single piece, galvanized, standard assembly with 12 gauge plate.
1. Finish: Hot-dipped galvanized, ASTM A153, Class B-2, (1.5 ounces per square foot).
2. Wall Tie: 3/16 inch wire pintle
3. Screw Type: 5/16 inch expansion anchor, corrosion-resistant.
4. Acceptable Manufacturer:
a. Heckman Building Products, Inc.: 103-C.
b. Comparable product of other specified manufacturers.

G. (BT-5) Column Web Tie: "U" shaped anchor 3/16 inch diameter by 12 inch long with 1 inch flat end for use with weld-on straps.
1. Anchors attached to weld-on straps No. 359.
2. Acceptable Manufacturer:
a. Hohmann and Barnard Incorporated Column Web Tie No 302W, 9 gauge wire.

H. (BT-6) Brick Tie at Columns: Weld-on strap ties, hot-dipped galvanized, with 1/4 inch holes.
1. Anchors attached directly to steel columns.
2. Acceptable Manufacturer:
a. Hohmann and Barnard Incorporated Offset Strap No.359FH with wire ties No.302W, 9 gauge wire.

I. (BT-7) Masonry to Steel Ties: Galvanized wire, wire and tie, with triangle ties in length indicated.
1. Acceptable Manufacturers:
a. Dur-O-Wal D/A 207 and D/A 709
b. Dur-O-Wal D/A 207 and D/A 750.

J. (BT-8) Hook and Pintle Adjustable Ties: Pintle section and eye section rectangular adjustable ties, 3/16 inch galvanized wire.
1. Acceptable Manufacturer:
a. Dur-O-Wal D/A 518.
b. Comparable product of other specified manufacturers.

K. Steel Wire Rods at Masonry Joints: ASTM A82. Use galvanized wire at exterior masonry walls.
1. Use mill galvanized wire Class 3 (0.8 oz. minimum zinc coating) for exterior masonry walls.

2.5 THROUGH WALL FLASHING, AND ACCESSORIES

A. (TWF-2) Through-Wall-Flashing: 40 mil thick, rubberized asphalt sheet flashing consisting of 32 mil pliable and highly adhesive rubberized asphalt compound bonded completely and integrally to 8 mil density, cross-laminated polyethylene film.

1. Primer: As recommended by flashing manufacturer for bonding flashing sheets to substrates.
2. Acceptable Product:
   a. Grace Construction Products: Perm-A-Barrier Wall Flashing.
   b. Carlisle Coatings and Waterproofing: CCW-705
   c. W.R. Meadows Incorporated: Sealtight Air Shield

B. Termination Bars: Stainless Steel bar predrilled at 8 inches on center

1. Size: 1/8 inch thick by1-1/2 inches high by 8 feet long
2. Fasteners: Stainless steel
3. Manufacturer:
   a. Dur-O- Wal: D/A 1510

C. Adhesives and Primers for Flashings: Flashing manufacturer's standard products or products recommended by the flashing manufacturer for bonding flashing sheets to each other and to substrates.

D. Sealant: Flashing manufacturer's standard products or products recommended by the flashing manufacturer to seal seam edges and terminations.

2.6 JOINT FILLER, DEFLECTION MATERIAL AND COLUMN WRAP

A. (MA-1) Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

1. Product and Manufacturer: RS Series Rubber Control Joints by Hohmann and Barnard, Inc..

B. (MA-2) Deflection Material: Pre-molded compressible filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.

1. Product and Manufacturer: NS Closed Cell Neoprene Sponge by Hohmann and Barnard, Inc..

C. (MA-3) Column Wrap: Open cell polyurethane foam, 1/4 inch thick.

D. (MA-4) Control Joint Bond Breaker:

1. Type: 6 mil thick polyethylene film.
2. Type: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.7 MASONRY CLEANER

A. Type and Manufacturer: Sure Klean masonry cleaner by PROSOCO Incorporated. Use masonry cleaner to clean all exposed masonry work. Type of cleaner as recommended by manufacturer for each type of masonry material.

B. Other Acceptable Manufacturers:

1. American Building Restoration Products, Inc., Franklin, WI.
2. L&M Chemicals,
3. Diedrich Technologies, Inc., Oak Creek, WI.

2.8 MORTAR MIX

A. Comply with ASTM C270 and U.B.C. Table No. 24-A for measurement of mortar materials, mixing of mortar and proportion specifications.

B. Use Type N mortar for all unit masonry work, except use Type S mortar which is to receive color additive and for mortar at unit masonry in contact with earth.

C. Thoroughly mix mortar ingredients, in quantities needed for immediate use.

D. Add mortar color and admixtures in accordance with manufacturer's recommendations. Ensure uniformity of mix and colorations.
   1. Consult with and follow manufacturer's directions on: Use, quantity and mixing of admixtures; various conditions affecting mixing and pouring; mix designs and procedures. Show proposed admixtures on mix designs and do not use unless shown.

E. Do not use anti-freeze compounds to lower freezing point of mortar.

F. Use mortar within 2 hours of mixing at temperatures over 80 degrees F, and 2-1/2 hours at temperatures under 50 degrees F.

G. If necessary, retemper mortar within 2 hours of mixing to replace water lost by evaporation. Do not retemper mortar after 2 hours of mixing.

2.9 UNIT MASONRY PATCHING MATERIALS

A. Masonry materials and workmanship for remodeling and patching at existing masonry work shall match existing.

PART 3 EXECUTION

3.1 PREPARATION

A. Ensure items built-in by other trades for this work are properly located and sized. Fill in solidly with masonry around built-in items. Fill space between hollow metal frames and masonry solidly with mortar.

B. Establish lines, levels and coursing. Protect from disturbances.

3.2 CONCRETE BLOCK INSTALLATION

A. Place masonry in accordance with lines and levels indicated on drawings. Lay from exposed side, plumb, level and true to modular dimensions.

B. Fully bond external and internal corners.

C. Install joint reinforcing, anchors and ties in full mortar surround and where necessary fill voids in blocks to provide full bed to completely imbed items.

D. Keep concrete block and brick dry, under cover and lay only clean, dry undamaged units. Do not lay units with moisture content over 40 percent.

E. Lay hollow concrete masonry units with full mortar coverage on vertical face shells. Bed webs in mortar in starting course.

F. Lay solid masonry units with completely filled bed and head joint, except at expansion and control joints. Butter ends with sufficient mortar to fill head joints and shove into place.
   1. Do not slush head joints.
   2. Bevel rear of bed joint at cavity to exclude mortar from protruding into cavity.

G. Isolate masonry partitions from vertical structural framing members with control joint, with mortar raked back 1/4 inch regardless of joint treatment.

H. Do not shift or tap masonry after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.

I. Ensure masonry courses are of uniform height. Make vertical and horizontal joints equal and of uniform thickness. in full bed of mortar, properly jointed with other work.

J. Remove excess mortar and projections. Take care to prevent breaking masonry corners. Do not let mortar fall into cavity air space, clean out promptly.

K. Perform job site cutting of masonry with proper power tools to provide straight and true, unchipped edges.

L. Lay exposed concrete block in running bond with vertical joint in each course centered on units in course above and below.

M. Where piping and conduit run in masonry, work with other trades to coordinate work. Cut out center bridges in block to create voids for pipes or conduit. Where pipes or conduit exit from wall, drill neat holes to provide neat unpatched walls.

N. Build inner wythe ahead of outer wythe to receive insulation or vapor retarder adhesive.

O. Mortar joints, that will be covered by earth, shall be struck flush and then tooled to dense sealed surface.

P. Tool exposed joints slightly concave to dense smooth surface without overlaps from horizontal to vertical joints. Tool exposed mortar when thumbprint hard. Joints behind ceramic tile shall be flush. Rake out mortar in preparation for application of sealants, where required.

3.3 TOLERANCES

A. Maximum variation from masonry unit to adjacent masonry unit is 1/16 inch.

B. Maximum variation from vertical and horizontal building lines is 1/4 inch in 10 feet.

C. Maximum variation from cross sectional thickness of cavity and composite walls is plus or minus 1/4 inch.

D. Maintain flush face on exposed masonry surfaces.

E. Lay concrete block to receive thinset ceramic tile plumb, with flush mortar joints and with maximum surface variation of 1/8 inch, in 10 feet.

3.4 REINFORCEMENT AND ANCHORAGES

A. Place masonry reinforcing and anchorages for unit masonry as indicated on drawings. If not indicated locate reinforcing as follows:

1. 16 inches o.c. vertical dimensions, continuous full length of wall.
2. At bed joint at top course of wall or partition, continuous full length of wall.
3. In first and second courses below and above each wall opening, extending at least 3 feet beyond opening jamb, in addition to continuous reinforcing noted under #1 above.
4. At foundation walls with earth both sides, provide only at top 2 courses.
5. At composite walls, without cavity, provide extended type reinforcing, full width (less one inch each side) of block and brick wythe.
6. Fully reinforce corners and intersections.
7. Lap masonry reinforcing splices minimum 6 inches.
8. Thoroughly embed wall ties for face brick.
9. Ensure that anchorage embedded in concrete, attached to structural steel members for concrete block are properly placed. Embed free end of anchorage in every second concrete block joint.
10. Reinforce walls, with continuous horizontal joint reinforcing and masonry ties. Fully embed longitudinal side rods in mortar for entire length with minimum cover of 5/8 inch on exterior side of walls and 1/2 inch at other locations.

3.5 MASONRY GROUTING

A. Place grout at intervals not to exceed 4 feet of wall height during construction of walls, unless cleanouts are provided in which case 8 foot lifts may be used.

B. Rod or vibrate grout to insure complete filling of cells.

C. Allow at least 15 minutes between successive pour lifts to permit settlement.

D. Stop intermediate pours at least 1-1/2 inches below mortar joint.

E. Exercise care during filling of cells to insure reinforcement is properly positioned. Tie vertical bars to joint reinforcing at 32 inches centers to maintain their proper location.

F. Use care to prevent mortar droppings from accumulating at base of cells. Provide temporary cleanout openings, if necessary, at base of cells in order to remove droppings prior to placement of grout.

3.6 BOND BEAMS AND LINTELS

A. Provide reinforced concrete block lintels over openings where indicated on drawings.

B. Construct lintels and bond beams using concrete and reinforcing steel. Maintain minimum 6 inch bearing on each side of openings. Erect on full even beds of mortar with minimum 3 courses of solid brick or one course filled- core hollow units under lintels and beams.

C. Construct lintels using PCA recommendations, with reinforcing bars of size indicated. Bars to project 1/2 inch at lintel ends.

D. Use reinforcing bars of full lengths only.

E. Place and consolidate concrete without disturbing reinforcing. Construct lintels on plank, adequately supported, joints equally spaced. Fill spaces around built-in items solid with masonry and mortar unless otherwise indicated. Clean out spaces prior to pouring concrete fill.

F. Allow lintels to reach maximum strength before removing temporary supports. Installation shall be minimum 2 weeks old before used to carry load. Remove units that show evidence of cracking.

3.7 JOINT FILLERS AND DEFLECTION MATERIAL

A. Install fillers in accordance with manufacturer's printed instructions. Compressible fillers shall be 50 percent larger than joint size.

B. Set units at proper depth or position in joint to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint filler units. Recess exposed edges or faces or compressible fillers slightly behind adjoining surfaces so that compressed units will not protrude from joint.

3.8 CONTROL JOINTS AND CONSTRUCTION JOINTS

A. Provide control joints in brick and block work as indicated and where shown on drawings.

B. Do not continue masonry reinforcing across joints.

C. Form joints in brick work, straight and true.

3.9 BUILT-IN WORK

A. As work progresses, build-in items as indicated and required, including, hollow metal frames, window frames, steel angle lintels, nailing strips, anchor bolts, plates, sleeves, hangers, supports, and other items supplied by other trades.

1. Wherever bolts, brackets and similar anchor items are cast-in masonry, fill voids in masonry with mortar to adequately anchor and transmit loads.

B. Build-in items plumb and true.

C. Bed anchors of hollow metal frames in mortar joints. Fill frame voids solid with mortar. Fill masonry cores at jambs with grout for full projection at frame anchors.

D. Do not build-in organic materials which will be subjected to rot or deterioration.

3.10 CUTTING AND FITTING

A. Cut and fit concrete block for chases, pipes, conduit, sleeves, and grounds. Cooperate with other sections of work to ensure correct size, shape and location. Provide not less than 8 inches of masonry between chase or recess and jamb of openings. Cut masonry units using motor-driven saws to provide clean, sharp, unchipped edges.

B. Obtain Architect's review prior to cutting or fitting any area not indicated on drawings, or which may impair appearance or strength of masonry work.

3.11 INTERIOR PARTITIONS

A. General: Carry masonry partitions up to structure above, unless otherwise noted.

B. Openings Through Walls: Except as otherwise indicated, where piping, conduit or similar features pass through walls, carefully fill spaces to block sound. Fill voids to permit movement and deflection. Fill solid around obstructions and voids to form effective closures.

C. Joint to Structure Above: Provide 3/8 inch joint between masonry and over- structure and pack solidly with Shok-Pak to form dense and effective barrier to sound transmission. Filling of voids shall permit movement and deflection. Fill solid around obstructions and voids to form effective closure.

3.12 CLEANING

A. Wipe off excess mortar as work progresses. Dry brush at end of each days work. Remove excess mortar and smears upon completion of masonry work.

B. Point or replace defective mortar. Match adjacent work.

C. After mortar is thoroughly set and cured, clean exposed surfaces with masonry cleaner in accordance with cleaner manufacturer's printed instructions. Use nonmetallic tools in cleaning operations.

D. Clean brick masonry in accordance with BIA Technical Notes on Brick Construction, 20 Revised 11, November 1990.

END OF SECTION

SECTION 051200
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Structural steel framing, steel lintels, embedded plates. steel beam bearing plates and other items defined as structural steel.
   2. Deformed bar anchors, anchor rods, expansion bolts and other incidental items of structural steel required to be built into concrete or masonry and attached to the structural frame.
   3. Shop priming of structural steel.
   4. Erection of structural steel.
   5. Grout below steel bearing and base plates.

B. Related Sections:
   1. Section 053100 - Steel Decking.
   2. Section 055000 - Metal Fabrications.
   3. Section 055100 "Metal Stairs."

1.2 REFERENCES

A. AISC 303: Code of Standard Practice for Steel Buildings and Bridges.

B. AISC 360: Specification for Structural Steel Buildings.

C. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

D. AWS D1.1: Structural Welding Code - Steel.

E. SSPC: The Society for Protective Coatings.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Submit fabrication and erection drawings in accordance with Section 013300. Show fabrication of structural-steel components. Before preparation of shop drawings and fabrication of materials affected by existing construction, field verify existing elevations, dimensions and conditions as shown on Contract Documents and report discrepancies to Architect for resolution. Submit all relevant drawings together so that review can be complete.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
   5. Indicate items to be galvanized, where required.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: For the following:
   1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   2. Direct-tension indicators.
   3. Tension-control, high-strength bolt-nut-washer assemblies.

4. Shear stud connectors.
5. Shop primers.
6. Nonshrink grout.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A fabricator experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.

B. Installer Qualifications: An experienced installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

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

D. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

B. Deliver anchor rods and anchorage devices to be embedded in cast-in-place concrete or masonry in ample time so as to not delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

D. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Only new and factory lubricated fasteners shall be used on the project. Fasteners that have become dry or rusty are not permitted.

E. Store welding electrodes in hermetically sealed containers. Electrodes exposed to the atmosphere for periods greater than those permitted shall be redried in accordance with AWS D1.1.

1.8 COORDINATION

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

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Structural Steel Shapes: See notes on structural drawings.

B. Welding Electrodes: Comply with AWS requirements.

C. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts or ASTM F 1852 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
   1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

D. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts or ASTM F 2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.
   1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

E. Anchor Rods: ASTM F 1554, Grade as noted on drawings, weldable
   1. Nuts: ASTM A 563 heavy-hex carbon steel.
   2. Plate Washers: ASTM A 36.
   3. Washers: ASTM F 436, Type 1, hardened carbon steel.

F. Threaded Rods: ASTM A 36.
   1. Nuts: ASTM A 563 heavy-hex carbon steel.
   2. Washers: ASTM A 36 carbon steel.

G. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A.
   1. Nuts: ASTM A 563 heavy-hex carbon steel.
   2. Washers: ASTM A 36 carbon steel.

2.2 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with reviewed shop drawings, AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Clip angles or other components shown welded to top flanges of beams, except for end connections, shall be shipped loose for attachment in field.
   6. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" or SSPC-SP 2, "Hand Tool Cleaning".

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

G. Where lintel and soffit plates are indicated with edge flush with masonry, horizontal leg shall either terminate 1/4 inch short of masonry at jambs, or be notched at end extending into masonry to permit mortar joints across face. At beam and plate lintels spanning from jamb to jamb of opening, stop plate short of masonry. Where bearing of horizontal leg is required at opening jamb, notch lintel end to permit full 3/4 inch of mortar cover along face.

2.5 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.6 SHOP PRIMING

A. Shop prime steel surfaces unless otherwise noted. Do not shop prime the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.

B. Shop prime steel surfaces concealed by interior building finish.

C. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
4. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   a. Provide at exposed structural steel surfaces.

D. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.7 SOURCE QUALITY CONTROL

A. Coordinate with Independent Testing Agency employed by the Owner to perform shop quality control inspection and testing listed below:
1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. High Strength Bolting:
1. Preparation: Visually inspect mating surfaces and bolt type for all slip-critical bolted connections for general conformance with the Contract Documents prior to bolting.
2. Slip Critical Bolts and Tension Bolts: Test bolt tightening in 10% of all bolts. Test a minimum of two bolts in each connection. Verify that all plies of connected elements have been brought into contact, at 100% of connections. Verify all splines are removed from "twist-off" tension control bolts.
3. Bearing Bolts: Visually inspect to confirm all plies of connected elements have been brought into contact, at 100% of connections.
4. Standard: Test and Inspect High Strength bolted connections per RCSC "Specifications for Structural Joints Using ASTM A325 or A490 Bolts,".

C. Welding:
   1. Fillet Welds: Visually inspect 100% of all fillet welds, for size, length and quality, per AWS D1.1.

D. Fabricator Certification: Testing of high strength bolting, fillet welds and partial penetration welds will be waived if fabrication shop participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is approved by the Authorities Having Jurisdiction and the Structural Engineer of Record.
   1. Testing requirements will be reinstated if work is considered questionable through visual observation of testing agency.

E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
   1. Set plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of baseplate.
   3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Structural Engineer of Record. Finish thermally cut sections within smoothness limits in AWS D1.1.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Do not field cut openings through structural steel members for passage of conduit, pipes, or ducts without obtaining written permission from Structural Engineer of Record. Wherever permission is given, provide openings and additionally reinforce member as directed by Structural Engineer of Record.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" and as indicated below for type of bolt and type of joint specified. If Twist-Off Tension-Control Bolts or Direct-Tension-Indicators are used, bolt assemblies shall be installed following recommendations of the manufacturer, and the following minimum requirements.

1. ASTM F 436, hardened carbon-steel washers shall be used at the following locations:
   a. To cover over-sized and slotted holes.
   b. Beveled washer at joint face with a slope greater than 1:20.
   c. Below the nut of a Twist-Off Tension-Control Bolt Assembly for Pretensioned, Slip-Critical and Bearing Joints when the spline is intended to be severed.
   d. Below the turned element when using a Calibrated Wrench Pretensioning method for Pretensioned and Slip-Critical Joints.
   e. At Pretensioned and Slip-Critical Joints with ASTM A490 bolts, under the bolt head or nut when bearing against connected material with a specified minimum yield strength less than 40 ksi.
2. For Pretensioned and Slip-Critical Joints, assemblies shall be initially installed as a Snug-tightened joint. For Slip-Critical Joints with Tension-Control Bolt assemblies, the initial Snug-tightened joint shall also be accomplished without severing the splined end. If a splined end is severed during this operation the bolt assembly shall be removed and replaced.
3. Snug-tightened condition shall bring the connected plies into firm contact. Compacting the joint to a snug-tight condition shall progress systematically from the most rigid part of the joint. Subsequent bolt tightening shall also progress systematically from the most rigid part of the joint.
4. Fastener components shall be protected from dirt and moisture in closed containers at the site of installation. Only as many fastener components as are anticipated to be installed during the work shift shall be taken from protected storage. Fastener components that are not incorporated into the work shall be returned to protected storage at the end of the work shift. Fastener components shall not be cleaned or modified from the as-delivered condition. Bolt assemblies that accumulate rust or dirt shall not be incorporated into the work.

3.5 FIELD QUALITY CONTROL

A. Coordinate with independent testing and inspecting agency engaged by the Owner to perform field quality control inspection and testing.

1. Provide necessary scaffolding or temporary platforms required by testing agency in order to perform their work. Such scaffolding or platforms shall comply with safety regulations and shall be acceptable to testing agency.

B. High Strength Bolting:

1. Preparation: Visually inspect mating surfaces and bolt type for all slip-critical bolted connections for general conformance with the Contract Documents prior to bolting.
2. Slip Critical Bolts and Tension Bolts: Test bolt tightening in 10% of all bolts. Test a minimum of two bolts in each connection. Verify that all plies of connected elements have been brought into contact, at 100% of connections. Verify all splines are removed from "twist-off" tension control bolts.
3. Bearing Bolts: Visually inspect to confirm all plies of connected elements have been brought into contact, at 100% of connections.
4. Standard: Test High Strength bolted connections per RCSC "Specifications for Structural Joints Using ASTM A325 or A490 Bolts,"

C. Welding:

1. Fillet Welds: Visually inspect 100% of all fillet welds, for size, length and quality, per AWS D1.1.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION

SECTION 053100
STEEL DECKING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Roof deck.
   2. Noncomposite form deck.
   3. Related accessories.

B. Related Sections include the following:
   1. Section 033001 - Cast-in-Place Concrete.
   2. Section 051200 - Structural Steel Framing.
   3. Section 055000 - Metal Fabrications.

1.2 REFERENCES

A. American Iron and Steel Institute (AISI) - North American Specification for the Design of Cold-Formed Steel Structural Members

B. Steel Deck Institute (SDI) - Publication No. 30 - Design Manual for Composite Decks, Form Decks, and Roof Decks.

C. American Welding Society (AWS) D1.1 Structural Welding Code - Steel.

D. American Welding Society (AWS) D1.3 Structural Welding Code - Sheet Steel.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with Section 013300. Show layout and types of deck panels, anchorage details, attachment patterns, field welding requirements, side lap fastenings, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

B. Product Data: Submit manufacturer's specifications/installation instructions for each type of deck, accessory, and product indicated.
   1. Include name of deck manufacturer, type, depth, uncoated steel thickness, and finish.

C. Product Certificates: For each type of steel deck, signed by product manufacturer certifying that the products furnished comply with the requirements.

D. Welding certificates: Signed by the contractor certifying that welders comply with the requirements.

E. Field quality-control test and inspection reports.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   1. Mechanical fasteners.

G. ICC- ES Evaluation Reports: Current evaluation reports by the ICC Evaluation Service indicating that the deck products provided are in compliance with the design requirements stated in the drawing and specification in accordance with the design code for the project.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide products from a manufacturer that is a member of the Steel Deck Institute.

B. Installer Qualifications: An experienced installer who has installed steel deck similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance.

C. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.

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

E. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

F. SDI Publications: Fabricate panels to comply with the dimensional parameters and Standard Load Tables defined in SDI’s “Design Manual for Composite Decks, Form Decks, and Roof Decks” or as shown in the drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Steel Deck:
   a. ASC Profiles, Inc.
   b. Canam Steel Corp.;The Canam Group.
   c. Consolidated Systems, Inc.
   d. DACS, Inc.
   e. D-Mac Industries Inc.
   f. Epic Metals Corporation.
   g. Marlyn Steel Decks, Inc.
   h. New Millennium Building Systems, LLC.
   i. Nucor Corp.; Vulcraft Division.
   j. Roof Deck, Inc.
   k. United Steel Deck, Inc.
   l. Valley Joist; Division of EBSCO Industries, Inc.
   m. Verco Manufacturing Co.
   n. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

2.2 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

1. Galvanized and Shop-Primed Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
   a. Color: Standard gray or white.
2. Deck Profile: As indicated on drawings.
3. Profile Depth: As indicated on drawings.
4. Design Uncoated-Steel Thickness: As indicated on drawings.
5. Span Condition: Minimum double span condition unless noted otherwise on drawings.
6. Side Laps: As indicated on drawings.

2.3 NONCOMPOSITE FORM DECK

A. Noncomposite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:

1. Galvanized and Shop-Primed Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33 minimum, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
   a. Color: Standard gray or white.
2. Profile Depth: As indicated on drawings.
3. Design Uncoated-Steel Thickness: As indicated on drawings.
4. Span Condition: As indicated on drawings.
5. Side Laps: As indicated on drawings.

2.4 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Welding Electrodes: Comply with AWS requirements.

C. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

D. Side-Lap Screw Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 12 minimum diameter unless indicated otherwise on drawings.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, of same thickness, material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

H. Flat Sump Plate: Single-piece steel sheet, 14 ga (0.0747 inch) thick, of same material and finish as deck. For drains, cut holes in the field.

I. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight. Comply with requirements of ASTM A 780.

J. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required by SDI specifications to meet deflection limitations and prevent overloading due to construction loads.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck provided that an equivalent connection capacity is obtained. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Install roof deck as specified below unless noted otherwise on drawings.

B. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches, and as follows:

1. Weld Diameter: As indicated on drawings.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated on drawings.

C. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at interval patterns indicated on drawings, and as follows:

1. Mechanically fasten with self-drilling, No. 12 diameter or larger, carbon-steel screws.
2. If deck is 18ga or heavier, fastenings may be welded with a minimum of 1-1/2-inch long welds.

D. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

E. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 8 inches apart with at least one weld at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and weld.

F. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

G. Support of light fixtures, ducts, pipes or other utilities from roof deck is not permitted.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

1. Deck Welds: Visually inspect size, location, length and burn-through for 100% of puddle welds on metal deck per AWS D1.3, Section 6.
2. Mechanical Fasteners: Visually inspect specified size, spacing, embedment and location.
3. Testing agency will report inspection results promptly and in writing to Contractor and Architect/Engineer.

B. Remove and replace work that does not comply with specified requirements.

C. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 055000
METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Miscellaneous and ornamental metal, except structural steel framing as specified in Section 051200 and defined as structural steel in AISC "Code of Standard Practice".
   2. Supports, anchorage and accessories for miscellaneous metal and ornamental metal work.
   3. Shop prime paint on ferrous metal.
   4. Shop prime for (Section 099600) high performance coating, where indicated.
   5. Channel support framing system.
   6. Steel framing, supports and mounting plates at overhead coiling doors.
   7. Guardrails.
   8. Bollards.

B. Related Sections:
   1. Section 051200 - Structural Steel Framing.
   2. Section 042000 - Unit Masonry.
   3. Section 089100 - Louvers.
   4. Section 099000 – Painting: Finish painting.
   5. Section 099600 - High Performance Coatings: Coating of Architecturally Exposed metal fabrication steel (AES).

1.2 REFERENCES

A. AWS D1.1 - Structural Welding Code.

B. SSPC PS7.01 - Steel Structures Painting Council.

C. Specification for Design of Cold-Formed Steel Structural Members by American Iron and Steel Institute.

D. ANSI A14.3 Safety Code for Fixed Ladders.

1.3 SUBMITTALS

A. Comply with Section 013300.

B. Shop Drawings: Indicate dimensions, description of materials and finishes; include plans, elevations, sections, and details of metal stairs and their connections and reactions to building structure. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections, and installation procedures, including specific requirements indicated.
   1. Indicate design criteria and reactions to structure.
   2. Construction details, sizes of metal sections, thickness of metals, profiles, attachments, dimensions and field joints, method of support from structure, and finishes.
   3. Work to be built-in or provided by other Sections.
   4. Welding: Indicate welded connections, both shop and field, using standard AWS welding symbols. Indicate net weld lengths.
   5. Provide shop drawings signed and sealed by qualified professional engineer responsible for their preparation licensed in State where project is located.
   6. Provide engineering calculations if requested.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.4 QUALITY ASSURANCE

A. Applicable Standards: AISC "Specifications for Design of Cold-Formed Steel Structural Members" and AWS "Structural Welding Code".

B. Qualification for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

C. Field Measurements: Take field measurements prior to fabrication to insure proper fitting of work.

D. Shop Assembly: Preassemble metal items in shop to greatest extent possible, so as to minimize field splicing and assembly. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

E. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this Project and with record of successful in-service performance, as well as sufficient production capacity to produce required units.

F. Professional Engineer Qualifications: Professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for installations of metal stairs (including handrails and railing systems) that are similar to those indicated for this Project in material, design, and extent of work.

G. Structural Performance of Guard Railings: Provide guard railings capable of withstanding following structural loads without exceeding allowable design working stress of materials for handrails, railings, anchors, and connections:

1. Top Rail of Guards: Capable of withstanding following loads applied as indicated:
   a. Concentrated load of 200 lbf applied at any point and in any direction.
2. Rails Not Serving as Top Rails: Capable of withstanding following loads applied as indicated:
   a. Concentrated load of 200 lbf applied at any point and in any direction.

1.5 HANDLING AND STORAGE

A. Load, unload, handle and store work in manner that will not bend, deform or otherwise damage metal. Store so metal and shop coats will not be subject to weather or moisture, store off ground and provide covering for metal in storage.

1.6 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. 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 MATERIALS

A. Metal Surfaces: For fabrication of miscellaneous metal work items which will be exposed to view, use only materials which are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names and roughness. Select steel for exposed work to provide best possible appearance.

B. Steel Plates, Shapes and Bars: ASTM A36.

C. Steel Tubing: ASTM A501 or ASTM A500.

D. Steel Pipe: ASTM A53, Type S, Grade A, standard weight and extra-strong as required, galvanized and plain.

E. Galvanized Sheet Metal: ASTM A526 or A527, G-90 coating designation with both sides of metal prime painted.

F. Galvanizing: ASTM A123, hot dip galvanizing, thickness Grade 55 unless otherwise indicated.

1. Galvanize exterior steel fabrications, steel at exterior wall locations, and where steel is exposed to weather.

G. Fasteners: As indicated and recommended by manufacturer. Provide zinc- coated fasteners for exterior use or where built into exterior walls.

1. Provide stainless steel fasteners where indicated and where dissimilar metals are connected. Where dissimilar metals are connected, provide neoprene spacer or washer for isolation.

H. Stainless Steel: ASTM A167, Type 304 with #4 finish. Passivate exterior stainless steel.

I. Metal Primer Paint: Provide comparable primer recommended by finish coat manufacturer which is lead and chromate free, Low VOC complying with VOC guidelines.

1. Primer for Metal to Receive High Performance Coatings (HPC): See Section 099600 for products to be applied by this Section.
2. Primer to Receive Fire Protection Treatment: See applicable Division 7 Section for primer to be applied by this Section.
3. Primers for Painting: See Section 099000 for primers to be applied by this Section.

2.2 FABRICATION

A. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to radius of 1/32 inch, unless otherwise shown. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

B. Weld corners and seams continuously and in accordance with AWS. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.

C. Form exposed connections with hairline joints which are flush and smooth, using concealed fasteners wherever possible.

D. Fabricate and space anchoring devices to provide adequate support. Cut, reinforce, drill and tap metal work to receive finish hardware and similar items.

E. Shop Painting: Remove scale, rust and other deleterious materials before shop coat of paint is applied. Apply shop coat of metal primer to fabricated metal items in accordance with manufacturer's printed instructions, with full coverage of joints, corners and edges.

F. Primer: High Performance Coating: At high performance painting use SSPC-6, complying with Section 099600.

1. Apply shop primer after surface preparation in compliance with primer manufacturer's instructions at a rate to provide uniform dry film thickness of 1.5 mils, maintain minimum coverage at joints, corners, edges and exposed surfaces.

2.3 HANDRAILS AND RAILINGS

A. Cope intersections of rails and posts, weld joints and grind smooth. Butt weld end-to-end joints of railing or use welding connectors.

1. Galvanize exterior handrails and railings.

B. Weld corners and seams continuously and in accordance with recommendations of AWS. Grind exposed welds smooth and flush, to match and blend with adjoining surface. Discoloration of finished surfaces is not acceptable.

C. Form exposed connections with flush, smooth, hairline joints, using concealed fasteners. Provide for anchorage to supporting structure. Fabricate and space anchoring devices as indicated and required for adequate support.

D. Provide brackets, flanges, and anchors for railing posts and for handrail supports. Provide inserts and sleeves for anchorage to concrete or masonry work.

E. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross-section of pipe throughout entire bend without buckling, twisting or otherwise deforming exposed surfaces of pipe.

F. Provide wall returns at ends of wall-mounted handrails, except where otherwise indicated.

G. Close exposed ends of pipe by welding 3/16 inch thick steel plate in place or by use of prefabricated fittings.

2.4 GUARDRAIL FABRICATION

A. General:
   1. Verify dimensions on site prior to shop fabrication.
   2. Fit and shop assemble sections in largest practical sizes, easily handled through building openings.
   3. Accurately form and fit components and connections. Grind exposed edges and welds smooth and flush.
   4. Accurately form components required for proper anchorage of stairs and landings, and integral railings to each other and to building structure.
   5. Thoroughly clean surfaces of rust, scale, grease, and foreign matter prior to galvanizing or prime painting. Allow to dry thoroughly before applying priming material.

B. Fabrication of Guardrails:
   1. Fabricate guard rails from 1-1/2 inch diameter schedule 40 pipe, fully welded and ground smooth
   2. Intermediate Guard Configuration provide one horizontal pipe rail at midpoint of guard rail height. If guard rail is located more than 30 inch from floor level provide a 1/4 inch by 4 inch steel plate, continuous at bottom of guardrail.
   3. Provide 3'-6" high guard rails.
   4. Prime paint interior rails

2.5 BOLLARDS

A. (MET FAB-8) Bollards Imbedded in Concrete: Hot-dipped galvanized steel pipe, 6 inch dia., 7 feet long, concrete filled, crowned cap, prime paint finish only the exposed top 3'-6".
   1. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
   2. Fill bollards solidly with concrete, mounding top surface to shed water.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which miscellaneous metal items are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Provide setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

C. Perform cutting, drilling and fitting required for installation of miscellaneous metal items. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.

D. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch up shop paint coat. Do not weld, cut or abrade surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

E. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

F. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 2 mils.

G. Erect stair work to line plumb, square, and true with runs registering level with floor and platform levels.

H. Install alternating tread stair and accessories according to reviewed shop drawings and manufacturer instructions.

I. Install channel support framing system and accessories in accordance with reviewed shop drawings and manufacturer's printed instructions.

J. Install metal gratings and supports according to reviewed shop drawings and manufacturer instructions.

3.3 HANDRAILS AND RAILINGS

A. Provide anchorage devices and fasteners for securing handrails and railings to in-place construction.

B. Adjust railing prior to securing in-place to ensure proper matching at butting joints and correct alignment. Secure posts and rail ends to building construction.

C. Anchor steel pipe rails in concrete by means of galvanized pipe sleeves set and anchored into concrete. Provide steel plate closure secured to bottom of sleeve and of width and length not less than one inch greater than sleeve. After post is inserted into sleeve, fill sleeve solid with quick-setting hydraulic cement.

D. Anchor rail ends to supporting structure with flanges welded to rail ends and bolted to supporting members in accordance with reviewed shop drawings. Secure handrails to walls with wall brackets and end fittings

END OF SECTION

SECTION 061000
ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concealed wood blocking and nailers.
   2. Wood furring and grounds.
   3. Pegboards.
   4. Preservative treatment.
   5. Anchors nails, bolts, and screws.

B. Related Sections:
   1. Section 079000 – Joint Protection.

1.2 DEFINITIONS

A. The following definitions apply to this section as they pertain to rough carpentry items.
   1. Rough Carpentry: Carpentry work not specified in other Sections and not used as exposed work.

1.3 DESCRIPTION

A. Concealed wood framing, blocking, sheathing, subflooring, underlayment, anchors, fasteners, adhesives, and related items, including accessories furnished and installed as specified herein.

1.4 SUBMITTALS

A. Product Data: Submit for carpentry in accordance with Section 013300, Submittals.
   1. Submit for sheathing, air infiltration barrier, vapor retarders, tapes, sealants, and miscellaneous products specified.

B. Certification:
   1. Submit letter certifying that lumber is kiln-dried to 15 - 19 percent moisture content, well seasoned, grade marked, trade marked and free from warp.
   2. Submit letter from treatment plant certifying that chemicals and process used and net amount of salts retained are in conformance with specified standards
   3. Submit letter certifying that fire-retardant treatment materials comply with requirements herein stated and local authorities having jurisdiction and that treatment will not bleed through finished surfaces.

1.5 QUALITY ASSURANCE

A. Lumber Standard:
   1. Comply with U.S. Dept. of Commerce Product Standard PS 20, including moisture content and actual sizes related to indicated nominal sizes.
   2. Comply with Standard Grading Rules No. 16 for West Coast Lumber.
   3. Comply with American Softwood Lumber Standard and with application grading rules of inspection agencies certified by American Lumber Standard Committee's (ALSC) Board of Review.
   4. Comply with lumber producer's inspection agency grading rules certified as conforming to "National Grading Rules for Dimension Lumber" established under Section 10 of PS 20 and local code standard.

B. Plywood Standard: Comply with U. S. Product Standard PS 1-74/ANSI A199.1; and Grades and Specifications, Performance-Rated Panels and Specifications by APA – The Engineered Wood Association local code standard. Each construction and industrial panel shall bear APA trademark and appropriate identification.

C. Lumber: Factory-mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying agency, grade, species, moisture content at time of surfacing and mill.
   1. Seasoning: Kiln-dry lumber to 15 - 19 percent moisture content, well-seasoned, grade marked, trade marked and free from warp.

1.6 DELIVERY, STORAGE AND HANDLING

A. Inspect wood materials for conformance to specified grades, species, and treatment at time of delivery to Project site.
   1. Reject and return unsatisfactory wood materials.

B. Provide facilities for handling and storage of materials to prevent damage to edges, ends and surfaces.

C. Keep carpentry materials dry.
   1. Store lumber and plywood in stacks with provision for air circulation within stacks.
   2. Protect bottom of stacks against contact with damp surfaces. Protect exposed materials against weather.
   3. Stack materials minimum 12 inches off ground, or if on concrete slab-on-grade, minimum 1-1/2 inches, fully protected from weather.
   4. Provide for air circulation within and around stacks and under temporary coverings.

D. Place spacers between each bundle of pressure treated materials treated with waterborne chemicals to provide air circulation.

1.7 PROJECT CONDITIONS

A. Environmental Impact: Products containing following materials will not be permitted:
   1. Urea Formaldehyde.
   2. Chromium in wood pressure treatment products.
   3. Arsenic.

1.8 COORDINATION

A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit, show location of furring, nailers, blocking, grounds and similar supports to allow attachment of other work.
   1. Coordinate work directly with other subcontractors as necessary to insure proper fitting, joining or to clearances of other work. Obtain templates as required to insure proper fitting.

PART 2 PRODUCTS

2.1 LUMBER

A. Dimension Lumber: Finished 4 sides, 15 percent maximum moisture content. Mark lumber "S-DRY".
   1. Light Framing: Construction grade Douglas Fir or Southern Pine, appearance grades where exposed.
   2. Boards: Construction grade.

B. (WD BLKG-1) Miscellaneous Lumber: Lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping and similar members. Wood nailers and blocking in contact with cementitious materials shall be (PPT-1) treated.
   1. Moisture content of 19 percent maximum for lumber items not specified to have wood preservative treatment.
   2. Grade: No. 3 or standard grade.

2.2 WOOD SHEATHING

A. (WD SHTG-1) Concealed Sheathing: APA, C-D touch-sanded plugged. Exposure 1, 3/4 inch, square edge, fire-resistive treated Douglas Fir.

B. (WD SHTG-2) Concealed Sheathing: APA C-D EXT touch-sanded plugged. Exposure Exterior, 3/4 inch, square edge, moisture treated, Douglas Fir.

C. (WD SHTG-9) Exposed Sheathing for Paint: APA, one or both sides exposed in finish work. Exposure 1, Veneer Grade B, APA A-B Group 1, 3/4 inch, square edge fire-resistive treated, Douglas Fir.

2.3 PEGBOARDS

A. (PB-1) Pegboard: Pressed wood fiber with resin binder, standard (tempered) grade, ANSI A135.4, 1/8 inch thick with 3/16 inch diameter holes at one inch o.c. (1/4 inch thick with 9/32 inch with holes at one inch o.c.)

2.4 PRESERVATIVE TREATMENT

A. Ammoniacal, or amine, copper quat ACQ: AWPA C22-92.

B. (PPT-1) Extent of Treatment:

1. Wood nailers and blocking in contact with cementitious materials.
2. Plywood at parapets.

C. Coat cut surfaces after treatment with brush coat of same preservative treatment. Allow preservative to dry prior to placing members.

2.5 FIRE-RETARDANT TREATMENT

A. (FRT-1) Fire Retardant Treatment: Pressure impregnation with fire-retardant chemicals.

B. Manufacturers:

1. Dricon by Arch Wood Products,
2. Pyro-Guard by Hoover Treated Wood Products,
3. D-Blaze by Chemical Specialties,

C. Lumber and Plywood Treatment:

1. Each piece to bear:
   a. UL FR-S rating (flame spread and smoke developed less than 25),
   b. Complying with extended 30-minute tunnel test, ASTM E84 or UL 723
   c. Meet interior Type A requirements in AWPA Standard C-20 for lumber and C-27 for plywood.
   d. And shall be registered for use as a wood preservative by the U.S. Environmental Protection Agency.
2. Treatment shall provide protection against:
   a. Termites,
   b. Fungal decay
3. Treatment shall be free of:
   a. Hologens
   b. Sulfates,
   c. Ammonium phosphate,
   d. Formaldehyde.

D. After treatment: Material shall be dried to an average moisture content of 15 percent or less for plywood and 19 percent or less for other lumber.

E. Complete fabrication prior to treatment to minimize cutting and jointing after treatment.

1. Coat surfaces cut after treatment with heavy brush coat of same fire-retardant chemical.

F. Do not use twisted, warped, bowed or otherwise damaged or defective pieces.

G. Extent of Treatment: Wood materials as part of fire-rated assemblies shall be fire retardant treated, and as indicated, with (FRT-1).

2.6 ROUGH HARDWARE, FASTENERS AND ANCHORAGE DEVICES

A. Extent: Provide rough hardware required, including nails, screws, bolts, lag screws, cinch anchors, toggle bolts, shot anchors and similar items.

B. General: Provide proper size and type for use intended and for materials to be fastened.
   1. Install adequate hardware to insure substantial and positive anchorage.
   2. Use hot-dipped galvanized or stainless steel fasteners for exterior locations and high humidity locations and treated wood, plain finish for other interior locations.
   3. Fasteners, hangers and bearing plates used on or in connection with treated wood shall comply with IBC 2304.9.

C. Nails: Conform to materials standards established under FS FF-N-105.
   1. At exterior work, use galvanized steel nails.
   2. Refer to IBC Nailing Schedule for quality and size.

2.7 TAPES, SEALANTS AND MISCELLANEOUS

A. Adhesive: As recommended by manufacturer of product to be applied for surface material to give permanent adhesion, with material remaining flat to back surface. Comply with local code standards.
   1. Comply with APA AFG-01 for adhesive for use with type of construction panel indicated.
   2. Exterior: Phenolic resin waterproof glue.
   3. Interior: Water-resistant casein and other adhesives suited for particular use.

B. Expansion Material: Dow Chemical Ethafoam. Use where expansion joint material is indicated and not installed under other sections.

C. Concealed Sealants: Polyisobutylene sealant
   1. Tremco's Curtainwall Sealer.

D. Soft Gasket or Urethane Insulation:
   1. Product: "Shok-Pak" flexible semi- closed cell urethane.
      a. Distributor: Brock-White Company, Minneapolis, Minnesota.
   2. Provide 1/2 inch thicker than joint where foam tape, foam gasket and urethane insulation is indicated and not provided under other sections.
   3. Location: At gaps between framing and other materials.

E. Sill Sealer Gaskets:
   1. Glass-fiber resilient insulation, fabricated in strip form for use as a sill sealer.
   2. Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

PART 3 EXECUTION

3.1 FRAMING, NAILERS, BUCKS, CANT STRIPS

A. Install plumb, level, true and square to dimensions shown and required. Allow for finishes and proper clearances where necessary.

B. Provide sound bearing, square cuts, and full bearing surfaces. Set crown up for horizontal members. Shim and block where required.

C. Eliminate crooked, twisted, cupped or bowed framing where required.

D. Anchorage: Adequately anchor, fasten and support members to form secure, substantial and accurate anchorage and to hold required dimensions and prevent twist.
   1. Use bolts and screws to eliminate loosening up of joints, sagging or similar movement.
   2. Use nailers for securing gravel stops, cornices, and where otherwise shown or required.

3.2 FURRING, STRIPPING, GROUNDS AND BACKING

A. Install plumb, level, true and square. Anchor substantially for permanent installation. Set and shim to straight edge so finish wall is true and straight.

B. Provide grounds and backing as shown or required. Blocking as required or shown on drawings for plumbing fixtures, brackets, drapery rods, window and door frames, built-in furniture and other woodwork, both interior and exterior.

C. Allow for finishes and shim out to form level surfaces. Verify ground sizes and locations before installation.

3.3 INSTALLATION OF SHEATHING

A. Install plywood in accordance with Plywood Construction Guide by APA – The Engineered Wood Association.

B. Place roof and wall sheathing with end joints staggered. Secure sheets over firm bearing.

1. Maintain minimum 1/16 inch and maximum 1/8 inch spacing between joints on walls. Place perpendicular to framing members.

C. Comply with roofing manufacturer's requirements for sheathing attachments.

3.4 FACTORY WOOD TREATMENT

A. Shop pressure treat and deliver to site ready for installation, wood materials requiring UL fire rating or pressure impregnated preservatives.

B. Provide UL approved identification on fire resistant treated materials.

1. Deliver fire retardant treated materials cut to required sizes so as to eliminate necessity of field cutting.

C. Ensure exposed materials requiring stain or paint finish do not exceed 15 percent moisture content before applying wood preservative treatment.

3.5 SITE TREATMENT OF WOOD MATERIALS

A. Apply preservative treatment in accordance with manufacturer's printed instructions.

B. Brush apply 2 coats of preservative treatment on wood in contact with cementitious materials and roofing and related metal flashings. Treat site-sawn cuts.

C. Allow preservative to dry prior to erecting members.

D. Ensure exposed materials requiring stain or paint finish do not exceed 15 percent moisture content before applying wood preservative treatment.

END OF SECTION

SECTION 070150.91
ROOFING RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:
   1. Roof tear-off at new openings for mechanical units
   2. Roof patching at new curbs over concrete deck.
   3. Protection of existing roofing system that is not reroofed.

B. Related Sections include the following:
   1. Division 01 Section "Summary" for use of the premises and phasing requirements.
   2. Division 01 Section "Cutting and Patching" for cutting and patching procedures for reroofing preparation.
   3. Division 06 Section "Rough Carpentry" for wood curbs.
   4. Division 23 Sections for HVAC equipment removal and reinstallation.

1.2 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Existing Membrane Roofing System: Built-up asphalt roofing membrane, surfacing, and components and accessories between deck and roofing membrane.

C. Partial Roof Tear-Off: Removal of a portion of existing membrane roofing system from deck or removal of selected components and accessories from existing membrane roofing system.

D. Existing to Remain: Existing items of construction that are not indicated to be removed.

1.4 SUBMITTALS

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

B. Fastener pull-out test report.

C. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.

D. Qualification Data: For Installer including certificate that Installer is approved by warrantor of existing roofing system.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer of new membrane roofing system approved by warrantor of existing roofing system to work on existing roofing.

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

1.6 PROJECT CONDITIONS

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

1. Coordinate work activities daily with Owner so Owner can place protective dust or water leakage covers over sensitive equipment or furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below the work area if desired.

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

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

D. Owner assumes no responsibility for condition of areas to be reroofed.

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

E. The results of an analysis of test cores from existing membrane roofing system are available for Contractor's reference.

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

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

1. 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.

1.7 WARRANTY

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

1. Notify warrantor of existing roofing system on completion of roof patching, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use roofing materials matching existing membrane roofing system materials, unless otherwise indicated.

2.2 RECOVER BOARDS

A. Recover Board: ASTM C 728, perlite board; minimum of 1/2 inch thick or as needed to match existing roof system.

B. Fasteners: Factory-coated steel fasteners, No. 12 or 14, and metal or plastic plates listed in FMG's "Approval Guide," designed for fastening recover boards to deck.

2.3 AUXILIARY REROOFING MATERIALS

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

B. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FMG's "Approval Guide."

C. Sheet Metal Flashing" (SMF-1): Prefinished galvanized metal, 24 gauge, complying with ASTM A525 G-90 shop coated with Kynar fluoropolymer coating in color as selected from manufacturers standard.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect existing membrane roofing system that is indicated not to be patched.
   1. Loosely lay 1-inch- minimum thick, molded expanded polystyrene (MEPS) insulation over the roofing membrane in areas indicated. Loosely lay 15/32-inch plywood or OSB panels over MEPS. Extend MEPS past edges of plywood or OSB panels a minimum of 1 inch.
   2. Limit traffic and material storage to areas of existing roofing membrane that have been protected.
   3. Maintain temporary protection and leave in place until replacement roofing has been completed.

B. Coordinate with Owner to shut down air intake equipment in the vicinity of the Work. Cover air intake louvers before proceeding with roof patching work that could affect indoor air quality or activate smoke detectors in the ductwork.

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

D. 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.

3.2 ROOF CUTTING AND PATCHING

A. General: Coordinate with Division 15 for opening schedule and final opening sizes.

B. Remove aggregate ballast from roofing membrane. Store aggregate ballast for reuse.

C. Remove existing roofing membrane and other membrane roofing system components down to the deck.
   1. Remove cover boards, roof insulation, and substrate boards.

D. Remove fasteners from deck or cut fasteners off slightly above deck surface.

3.3 DECK PREPARATION

A. Inspect deck after partial tear-off of membrane roofing system.
   1. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263. Do not proceed with roofing work if moisture condenses under the plastic sheet.

B. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify Architect. Do not proceed with installation until directed by Architect.

C. If deck surface is not suitable 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 INSPECTION OF EXISTING DECK

A. Immediately after removal of selected portions of existing membrane roofing system, and inspection and repair, if needed, of deck, fill in the tear-off areas to match existing membrane roofing system construction.
   1. Provide temporary protection during installation of new curbs, if needed.

3.5 ROOF PREPARATION

A. Remove blisters, ridges, buckles, and other substrate irregularities from existing roofing membrane that inhibit new recover boards from conforming to substrate.
   1. Broom clean existing substrate.
   2. Verify that existing substrate is dry before proceeding with installation of roofing. Spot check substrates with an electrical capacitance moisture-detection meter.
   3. Remove materials that are wet or damp.

3.6 ROOFING INSTALLATION

A. General Responsibility: Perform no work in conflict with, contrary to, or below standards established by roofing or membrane materials manufacturer. After starting work, roofer is responsible for complete water integrity of membranes, checking work installed on roof and other membranes, and for properly applied membrane. Therefore roofer shall:
   1. Not apply membranes or other work under conditions which are not proper and in best recommended practices, including surfaces or weather.
   2. Not overheat bitumens and in event of accidental high temperatures, discard entire batch.
   3. Not install any felts or other materials that have been exposed to moisture, store felts off ground and cover with waterproof membrane. Discard felts that have been exposed to moisture.
   4. Review drawings and specification requirements and establish control and test procedures to insure compliance.
   5. Exercise care to insure adequate quantities of materials are used.
   6. Maintain competent foreman continuously supervising work, with authority to discard unsuitable materials or remove unsatisfactory workmen.
   7. Supervise installation of and be responsible for seeing that drains, curbs and other work are properly set and roof is not damaged; make roof and flashing repairs as necessary.

B. Bituminous General Requirements
   1. Maximum bitumen temperature in heating equipment.
      a. Bitumen shall not be heated to minimum flashpoint.
      b. Minimum finished blowing temperature for asphalt shall not be exceeded for more than total of 4 hours for any asphalt batch, or portion thereof.
      c. Remove from project bitumen heated above these limits.
   2. Temperatures at time and point of application:
      a. Bitumens shall be within 25 degrees F of their equiviscous temperature when applied in roof system.
      b. Bitumens not meeting this criteria shall be reheated or allowed to cool, as required.
   3. Rate of Bitumen Application:
      a. Insulation: 30 lbs. per 100 square feet.
      b. Interply moppings for membrane, and over insulation: 27 lbs. per 100 square feet of asphalt, with tolerance of -15 percent and +15 percent.
      c. Flood coat: 60 lbs. per 100 square feet of asphalt.

C. Insulation Installation:
   1. Use full moppings of asphalt for application of each layer of insulation, and for applying insulation to concrete deck.
   2. Use full moppings of asphalt for application of each subsequent layer of insulation.
   3. Maximum moisture content of insulation at time of application shall be 4 percent of dry weight.
   4. Place each insulation board while bitumen still tacky.
   5. Step-down, or roll-down, insulation layers so that full embedment and flat surface is obtained.
   6. Stagger joints of upper layer with joints of bottom layer and stagger short joints in each layer. Stagger joints minimum of 25 percent of board dimension.
   7. Lay with edges in moderate contact, but do not force into place.
   8. Fill insulation joints wider than 1/4 inch with insulation cut to fit.
   9. Install tapered insulation with primed side up or between layers of insulation.
   10. Provide tapered edge strip at locations as indicated.
   11. Top surface of insulation shall be smooth and continuous with primed surface exposed to receive new membrane.

12. Provide extra care to properly cut and fit insulation boards to conform to changes in deck slope and other irregularities.
13. Install rigid perlite insulation re-cover board over tapered insulation.

D. Membrane Installation
1. Install number of plies to match existing roofing system.
2. Glaze coat of installed plies required if flood coat and gravel surfacing cannot be installed same day.
3. Maximum moisture content of felts at time of application shall be one percent of dry weight.
4. Provide full, uniform moppings of asphalt for membrane construction so that felt shall not touch felt.
5. Broom, or press, felts into hot bitumen providing tight, smooth laminations without wrinkles, buckles, kinks or "fishmouths". Air void pockets, as determined by test samples, shall not exceed 5 percent per interply mopping for individual sample and average of all samples shall be less than 3 percent per interply mopping.
6. Application of hot asphalt on surface that causes foaming of asphalt shall be cause for rejection of roof area.
7. Carry roofing plies up to top of cant strip and cut off evenly.
8. Install roofing plies in continuous shingle-type sequence such that there are no laps against flow of water.
9. Metal flanges for flashing sleeves shall be primed and set in trowel coat of plastic cement and stripped in with 3 plies of fiberglass felts and hot bitumen moppings.

E. Installation of Base Flashing
1. Install where roofing system joins vertical or canted surfaces.
2. Install base flashing membrane in full mopping of steep asphalt, with minimum temperature of 400 F. at application, by mopping surface to receive membrane and 2 back-mopping membranes. Fully embed membrane into mopping by rubbing membrane in by hand, so as not to create voids. Do not stretch membrane. End laps shall be 4 inch sealed with roofing cement and reinforcing fabric.
3. Fasten base flashing at top edge with specified fasteners at 8 inch on-center for wood and seal top edge of base flashing with trowel coat of roofing cement.
4. Install membrane flashing sheets under sheet metal work immediately after base flashing is completed. Minimum 3 inch laps shall be fully cemented with adhesive recommended by manufacturer.

F. Installation of Miscellaneous Sheet Metal Flashing:
1. Install counter flashing at mechanical curbs after installation of membrane flashing
2. Coordinate design with mechanical equipment.
3. Secure to mechanical curbs with screws.

G. Installation of Aggregate Surfacing
1. Insure that roof surfaces are clean, dry and free of loose gravel.
2. Pour flood coat uniformly over roof surface prior to installation of exposed sheet metal flashing.
3. Apply aggregate uniformly into hot bitumen with complete coverage, 400 lbs. per 100 square feet.

3.7 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.

B. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 DISPOSAL

A. Collect and place demolished materials 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 will not be permitted.

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

END OF SECTION

SECTION 076210
PREFINISHED SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Prefinished sheet metal flashing, roof edge, coping, expansion and contraction joint covers, parapet wall covers.
   2. Counter flashings for roof hatches and roof mounted mechanical equipment/services.
   3. Membrane flashing liner under metal flashing and sheet metal.
   4. Sealant concealed within sheet metal.

B. Related Sections:
   1. Section 061000 - Rough Carpentry: Wood blocking, nailers, grounds.
   2. Section 079000 - Joint Protection: Exposed sealants.

1.2 REFERENCES

A. "Architectural Sheet Metal Manual" standard industry details by SMACNA.

1.3 PERFORMANCE REQUIREMENTS

A. Install sheet metal and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking and fastener disengagement.

B. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 013300.
   1. Clearly detail shaping, jointing, length of sections, fastening, and installation details.

B. Samples: Submit in accordance with Section 013300 indicating metal finish.

C. Warranty: Submit 2 copies of manufacturer's written warranty.

1.5 QUALITY ASSURANCE

A. High performance roof edge system shall be certified by the manufacturer and/or fabricator to comply with ANSI/SPRI Standard ES-1.

1.6 PROJECT/SITE CONDITIONS

A. Exercise care when working on or about roof surfaces to avoid damaging or puncturing membrane or flexible flashings.

B. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

1.7 WARRANTY

A. Special Finish Warranty: Submit manufacturer's 20 year written warranty covering failure of the factory-applied exterior finish on sheet metal and agreeing to repair finish or replace sheet metal that evidences finish deterioration. Deterioration of finish includes, but is not limited to, color fade, chalking, cracking, peeling, and loss of film integrity.

PART 2 PRODUCTS

2.1 MATERIALS

A. Type and Manufacturer (SMF-2): Ryerson ColorKlad pre-finished aluminum flashing, ASTM A525 G-90 shop coated with Kynar fluoropolymer coating in color as selected by Architec.

B. Other Acceptable Sheet Metal Manufacturers: Peterson Aluminum Pac-Clad, Firestone Metal Products Una-Clad, Berridge Manufacturing, Dura Clad.

C. Anchorage: Nails and screws of hot dip zinc coated steel. Use screws where exposed anchorage is required. Screws minimum 1-1/2 inch long with neoprene washer under screw head. Exposed surfaces with finish to match color of sheet metal.

D. Concealed Sealant: Tremco curtain wall sealant.

E. Membrane Flashing:

1. (MEMB FLASH-1): Cold-applied self-adhering membrane of rubberized asphalt integrally bonded to polyethylene sheeting, Ice and Water Shield by Grace Construction Product.
   a. Other Acceptable Manufacturers:
      1) Polyken Technologies Polyken 640 Ice-O-Late.
      2) Carlisle Coatings & Waterproofings WIP 300HT.
2. Accessories: Furnish auxiliary materials including sheet flashing and bonding adhesive, recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

2.2 FABRICATION

A. Factory fabricate metal flashing and sheet metal in accordance with reviewed shop drawings and standard industry details by SMACNA in "Architectural Sheet Metal Manual."

B. Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrate and conditions under which flashing and sheet metal work is to be performed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sheet metal work in accordance with reviewed shop drawings and Architectural Sheet Metal Manual with sharp clean breaks.

B. Lower edge of flashing, counter flashing and exposed metal edges shall be turned back into hemmed edge.

C. Flashing shall be securely fastened and water and weatherproof. Neatly install with sharp clean breaks. Metal work at roof shall meet roofer's requirements and approval.

D. Butt and locked joint in metal work shall be watertight. Joints shall be lapped in direction of flow.

E. Provide lead wedges where required to hold metal firmly in place.

F. Install work with proper allowance for expansion and contraction from thermal changes.

G. Prior to starting work, nailers and blocking shall be true to size and line and securely anchored. Do not proceed until corrections are made so straight, level, plumb and properly sized work results.

H. Carefully form flashings, including at masonry, to conform to material dimensions as shown and according to field dimensions as verified.

I. Join lengths of gutters and downspouts with formed seams sealed watertight. Flash and seal gutters to downspouts. Slope gutters to downspout.

3.3 LOCATION OF JOINTS IN METAL

A. Center roof edge cover joints on other building features, symmetrical on facade, with joints not to exceed 10 feet o.c., as directed by Architect.

B. Joints in other metal work may be placed where convenient to metal lengths, not to exceed 10 feet lengths.

C. Cut metal for installations to maintain uniform 1/4 inch joint.

3.4 TYPES OF METAL END JOINTS

A. Flush, butt type with backplate for expansion at: Roof edge covers and expansion joint covers.

B. Cover strip over joint, with single lock seam: Typical curb covers.

C. Lapped joints at: Counter flashing, reglets, and similar cover type metal.

3.5 CONSTRUCTION OF END JOINTS

A. Butt Joints with Backplate for Expansion: Provide backplates same gauge and metal as flashing, 6 inch wide (2-7/8 inch each side of joint) conforming to exact shape of back of metal and full profile of metal after forming (except hems).

1. At both ends of each length of flashing metal, provide not less than 3 bent clips riveted near end, to receive backplate. Backplates are to slip under bent clips and shall form tight contact with flashing or cover metal.
2. In installation, butter bed of sealant on backplate and slide section of metal onto backplate, such that backplate fits into clips to hold metal tight and in perfect alignment. Repeat until metal has been set. At joints, install screws with neoprene washers through backplate without fastening to metal flashing length. (Notch out ends of flashing metal to accommodate screw heads and to eliminate obstructions for metal expansion.) Provide screw with neoprene washer at center of each length of roof metal flashing. Provide keepers or cleats to keep metal in place.

B. Locked Cover Strips: Cover strip shall have same profile as flashing and be formed with single lock seam to metal each side of joint. Locked seam joints shall have about 3/4 inch seam lock, with flashing spaced about 3/8 inch and shall permit movement at each joint.

C. Lapped Joints: Lap 3 inches in direction of water flow. At counterflashings, lock bottom edges together.

D. Sealant: Apply concealed sealant in accordance with requirements of Section 079000 - Joint Sealers.

E. At corners, inside or outside type, provide neat corner sections built-up in shop; with soldered joints and follow profile of adjacent metal. No nails permitted at exposed surfaces of exposed roof metal, only screws shall be used. Set roof edges in cooperation with roofer. Form angles to lesser degrees than required to insure snug fit after installation.

3.6 MEMBRANE FLASHING

A. Install membrane flashing as liner directly under sheet metal. Install membrane in accordance with manufacturer's directions to maintain watertight integrity of flashing materials and installation. Lengths shall be as long as possible by rolls of material. Lap ends minimum 2 inches, seal entire lap with adhesive and clean free of residue.

3.7 COUNTERFLASHING AND CURB FLASHING

A. Install metal counterflashing after membrane flashing is installed. Secure with screws through neoprene washers and locate not to exceed 18 inches o.c. Lap joints and lock lower edges together.

B. Install counterflashing to provide watertight closure over top of roofing flashing. Corners at curbs shall be sealed watertight. Height of counterflashing above membrane as indicated, with counterflashing carried down 45 degrees cant strip to about 1/2 inch above roof insulation. Bottom edge shall be hemmed (turned back) to eliminate sharp edges.

C. Counter-flash mechanical and electrical items projecting through membrane roofing.

3.8 CLEANING

A. Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration of finishes.

END OF SECTION

SECTION 079000
JOINT PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior and interior sealants.

B. Related Sections:
   1. Section 033000 – Cast-in-Place Concrete: Sealant in conjunction with exterior horizontal concrete joints.
   2. Section 076210 - Sheet Metal Flashing and Trim: Sealant concealed within sheet metal.
   3. Section 088000 - Glazing: Glazing sealant.
   4. Section 093000 - Tiling: Sealant in tile work.
   5. Section 321313 – Concrete Paving: Sealant in conjunction with concrete joints in curbs.

1.2 SUBMITTALS

A. Comply with Section 013300, unless otherwise indicated.

B. Product Data: Manufacturer's specifications and technical data including performance, construction and fabrication.
   1. Manufacturer's installation instructions for specific substrates on surface preparation and application for each type of sealant specified.
   2. Indicate joint dimensions and description of sealant.

C. Color Samples: 2 sets of manufacturer's full color range for each type of sealant specified.

D. Quality Control: Comply with Section 014500.
   1. Statement of qualification for manufacturers and installers.
   2. Statement of compliance for compatibility of sealant with adjacent materials and coatings.
   3. Field Quality Control submittals as specified in Part 3 of this Section.
      a. Field adhesion tests.
      b. Manufacturer's Field Services: For sizing of foam gasket seals and compressible seals.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with record of successful in-service performance.

B. Provide materials for exterior envelope from a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi component materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.5 PROJECT CONDITIONS

A. Weather Conditions: Do not proceed with installation of sealant under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
   1. Proceed with work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength.

2. Wherever joint width is affected by ambient temperature variation, apply elastomeric sealant only when temperatures are in lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.

B. Joint Width Conditions: Do not proceed with installation of joint sealers when joint widths are less than allowed by joint sealer manufacturer for application indicated.

C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

D. Compatibility and Adhesion Testing: Ascertain sealant compatibility and adhesion with adjacent materials using laboratory testing procedures.

PART 2 PRODUCTS

2.1 SEALANT MATERIALS

A. 1-Part Polyurethane Sealants: Polyurethane based one part elastomeric sealant, complying with FS- TT-S-00230C, Type II Class A, with elongation and compression of not less than 25 percent. ASTM C920, Type S, Class 25, Grade NS.

1. Acceptable Manufacturers and Products:
   a. Sika Chemical Corporation: Sikaflex-1a.
   b. BASF Building Systems: Sonolastic NP-1.
   c. Tremco Incorporated: Dymonic.
   d. Pecora Corporation: Dynatrol I.
   e. Tremco Incorporated: Vulkem 116.

B. 2-Part Polyurethane Sealant for Horizontal Applications: Self-leveling polyurethane based 2 part elastomeric sealant, complying with FS-TT-S-00227E, Type I, Class A, with shore A hardness of not less than 30 and elongation and compression of not less than 25 percent. ASTM C920, Type M, Class 25, Grade P.

1. Acceptable Manufacturers and Products:
   a. Tremco Incorporated: THC900.
   b. BASF Building Systems: Sonolastic SL-1 or 2.
   c. Pecora Corporation: Urexpan NR-200.

C. Low-Modulus Silicone Rubber Sealant: Silicone rubber based, one part neutral cure elastomeric sealant with plus 50 percent to minus 50 percent movement complying with FS-TT-S-001543, Class A, and recommended by manufacturer for joints.

1. Acceptable Manufacturers and Products:
   a. General Electric: Silpruf SCS 2000.
   b. Dow Corning Corporation: 795 Building Sealant.
   c. BASF Building Systems: Sonolastic Omniseal or OmniPlus.
   d. Pecora Corporation: 864 Silicone.
   e. Tremco Construction Division: Spectrem 3.

D. Ultra Low-Modulus Silicone Rubber Sealant: Silicone rubber based, one part neutral cure elastomeric sealant with plus 100 percent to minus 50 percent movement complying with FS-TT-S-001543, Class A.

1. Acceptable Manufacturers and Products:
   a. Dow Corning Corporation: 790 Building Sealant.
   b. Precora Corporation: 890 Silicone
   c. Tremco Construction Division: Spectrem 1.

E. Mildew-Resistant Silicone Rubber Sealant: Silicone rubber based, one part mildew resistance sealant with integral fungicide complying with FS-TT-S-001543A, Class A. Specifically recommended by manufacturer for interior joints in wet areas around plumbing fixtures and ceramic tile.

1. Acceptable Manufacturers and Product:
   a. General Electric: Sanitary 1700 Sealant.

b. Dow Corning Corporation: Silicone 786 mildew resistant.
c. Tremco Construction Division: Tremsil 600.

F. Acrylic Sealants: General purpose, paintable acrylic-emulsion sealant. Caulk with approximately 12- 1/2 percent elongation complying with ASTM C834.
1. Acceptable Manufacturers and Products:
a. Tremco Incorporated: Acrylic Latex 834.
b. BASF Building Systems: Sonolac.
c. Pecora Corporation: AC-20.

G. Colors: Colors as selected by Architect from manufacturer's standard colors. Acceptance of sealant will depend on range of standard colors available for selection.

2.2 JOINT SEALANT BACKING

A. Joint Sealant Backer Rod Manufacturers:
1. Denver Foam, Backer Rod Manufacturing, Inc.
2. Sonneborn Sonolastic, BASF Building Systems.
3. Construction Foam Products, Nomaco Inc..

B. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

C. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
1. Provide Type C closed-cell backings at horizontal applications and at acoustically-rated assemblies.
2. Use of Type O open-cell backing is acceptable only as approved by Architect for joints meeting the following conditions:
a. Closed-cell backing cannot accommodate joint movement;
b. Joint is not exposed to moisture;
c. Joint is not horizontal;
d. Joint is not in an acoustically-rated assembly.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.3 ACCESSORIES

A. Joint Primer: Non-staining type recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive type recommended by sealant manufacturer; compatible with joint forming materials.

C. Bond Breaker: ASTM C962, pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joint surfaces, backing, and anchorage of units forming sealant rabbet, and conditions under which sealant work is to be performed. Do not proceed with sealant work until unsatisfactory conditions have been corrected.

3.2 JOINT SURFACE PREPARATION

A. Clean joint surfaces immediately before installation of sealant. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealant.

B. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5 percent solution of muriatic acid; neutralize with dilute ammonia solution, rinse thoroughly with water and allow to dry before sealant application.

C. Roughen joint surfaces on vitreous coated and similar non-porous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce dull sheen.

D. Ensure that joint forming materials are compatible with sealant.

E. Examine joint dimensions and size materials to achieve required width/depth ratios. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

3.3 SEALANT APPLICATION

A. Apply sealant in accordance with manufacturer's printed instructions. Perform work in accordance with ASTM C1193.

B. Prime or seal joint surfaces. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

C. Install sealant backer rod for liquid elastomeric sealant, except where recommended to be omitted by sealant manufacturer for application shown.

D. Install bond breaker tape wherever required by manufacturer's recommendations to ensure that elastomeric sealant will perform properly.

E. Employ only proven installation techniques, which will ensure that sealant will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides.

1. Except as otherwise indicated, fill sealant rabbet to slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between horizontal surface and vertical surface, fill joint to form slight cove, so that joint will not trap moisture and dirt.

F. Install sealant to depth as shown or, if not shown, as recommended by sealant manufacturer but within following general limitations, measured at center (thin) section of bead:

1. For sidewalks, pavements and similar joints sealed with elastomeric sealant and subject to traffic and other abrasion and indention exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.
2. For normal moving joints sealed with elastomeric sealant, but not subject to traffic, fill joint to depth equal to 50 percent of joint width, but not more than 1/2 inch deep nor less than 1/4 inch deep.

G. Interior joints not subject to movement, these are:

1. Gypsum board to masonry joints.
2. Gypsum board to hollow metal joints.
3. Gypsum board to concrete joints.

H. Do not allow sealant or compounds to overflow or flow onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough texture surfaces. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either primer/sealer or sealant.

I. Remove excess and spillage of sealant promptly as work progresses. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes.

J. Rope Wicks: Where wicks for weeping masonry cavity occur in sealant, cut wick flush with sealant face and do not seal wick ends.

3.4 FIELD QUALITY CONTROL

A. Sealant Adhesion Field Test: Comply with following.

1. Weathering Sealant Adhesion: After liquid-applied sealant is fully cured, perform sealant adhesion test according to sealant manufacturer's recommendations.

3.5 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating operations or other causes so that they are without deterioration or damage at time of Substantial Completion.

1. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealant or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.6 SCHEDULE

A. Provide sealant where indicated (SLNT) or as required to achieve a weather-tight assembly.

B. The following schedule is not intended to be all inclusive.

1. Interior Joints at Unit Masonry to Unit Masonry: Low modulus silicone sealant.
2. Joints subject to Pedestrian or Vehicle Traffic: Use 2 part, self leveling polyurethane sealant.
3. Interior Joints Subject to Movement: One part polyurethane sealant.
4. Interior Joints NOT Subject to Movement: Acrylic sealant.

END OF SECTION

SECTION 081113
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pressed steel hollow metal doors and frames.
   2. Hollow metal window-walls, glazed openings, and other hollow metal frames for glass.
   3. Rough bucks, frame reinforcing, door reinforcing, door insulation, closure panels, clip angles and anchorage.
   4. Factory prime paint finish.

B. Related Sections:
   1. Section 083100 - Access Doors and Panels.
   2. Section 087100 – Door Hardware: Finish hardware, weather-stripping and sound-stripping.
   3. Section 088000 - Glazing: Glass and glazing.
   4. Section 099000 – Painting: Finish painting.

1.2 REFERENCES

A. ANSI/SDI-100-83 - Recommended Specifications - Standard Steel Doors and Frames, Steel Door Institute, unless herein specified.

B. Underwriters' Laboratories Inc. (UL) UL63, Factory Mutual (FM), or Warnock Hersey as applicable to fire rated hollow metal assemblies and acceptable to authorities having jurisdiction.

C. NFPA No. 80 - Fire Doors and Windows.

D. ANSI A115.1-.17 - Specification for Door and Frame Preparation for Hardware.

E. ANSI A156.7 (Supersedes CS9-65) - Standard Template Hinge Dimensions.

1.3 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 013300. Indicate general construction, configurations, jointing methods, reinforcements, and location of hardware and cutouts for glass and louvers.

1.4 QUALITY ASSURANCE

A. Applicable Standards: Specifications and standards of SDF 100-83.

B. Installer Qualification: Experience with installation of similar materials.

1.5 PRODUCT HANDLING

A. Deliver hollow metal doors in manufacturer's protective covering. Handle hollow metal with care to prevent damage.

B. Door Storage: Store doors in upright position, under cover. Place doors on at least 4 inch wood sills or on floors in manner that will prevent rust and damage. Do not use non-vented plastic or canvas shelters which create humidity chamber and promote rusting. If corrugated wrapper on door becomes wet, or moisture appears, remove wrapping immediately. Provide 1/4 inch space between doors to promote air circulation.

C. Frame Storage: Store frames under cover on 4 inch wood sills on floors in manner that will prevent rust and damage. Do not use non-vented plastic or canvas shelters which create humidity chamber and promote rusting. Store assembled frames in vertical position, 5 units maximum in stack. Provide 1/4 inch space between frames to promote air circulation.

PART 2 PRODUCTS

2.1 HOLLOW METAL

A. Acceptable Manufacturers: Trussbilt, Mesker, Pioneer, Steelcraft, Curries, Ceco, North Central Supply, Precision Metals, Republic, Kewanee, Security Metal Products.

B. Cold Rolled Steel Sheets: Cold formed, prime quality pickled, annealed stretcher level steel, free from scale, pitting or other surface defects, complying with ASTM A366.

C. Minimum gages of hollow metal are specified below. Provide heavier gage if required by details or specific condition. Entire frame and sidelight shall be of same gage.

1. 16 gage: Interior door frames, and glazed opening frames.
2. 16 gage: Labeled frames (or heavier if required by label).
3. 18 gage: Interior doors (or heavier if required by label).
4. 20 gage: Trim members.

2.2 RELATED MATERIALS

A. Steel Reinforcing: ASTM A36.

B. Door Bumpers or Silencers: GJ-64.

2.3 HOLLOW METAL FRAMES

A. General: Provide frames as full profile welded unless otherwise indicated. Where necessary, alternate details will be considered provided design intent is maintained. Consider and provide for erection methods.

B. Typical Reinforcing: Provide minimum hinge reinforcement 3/16 inch by 1-1/2 inch by 9 inch and lock strike reinforcement 3/16 inch by 1-1/2 inch by 4 inch long. Provide similar reinforcement for hardware items as required to adequately withstand stresses, minimum 12 gage, including channel reinforcement for door closers and closer arms, door holders and similar items. Provide reinforcement and clearances for concealed in-head bar closers and for mortise locks.

C. Cover Plates: For hinge and strike plate cutouts, provide fully enclosed pressed steel cover boxes spot welded to frames behind mortises.

D. Hardware: Mortise, reinforce, drill and tap for mortise hardware, except drilling and tapping for surface door closers, door closer brackets and adjusters shall be done in field.

E. Anchorage: Provide standard and special anchorage items as required. Provide 12 gage angle clips at bottom of frames with punched holes for securing frames to floor, except where frames are secured entirely by rough bucks. Provide formed steel channel spreader at bottom of frames, removable without damaging frame. At masonry, provide anchors (about 2 inch by 10 inch) approximately 24 inches on center.

F. Silencers: Provide specified silencers, except where stop does not occur and at smoke gasketed openings, 3 per jamb at single door and one for each door at double doors.

G. Extensions: Reinforce transom bars or mullions as necessary to provide rigid installation. Where required (as at multiple openings) to stabilize large frames, provide frame or mullion extensions to anchor to structure above, proper size to fit within overhead construction. Provide angle clips to fasten to structure.

H. Mullions: Provide mullions, continuously reinforced, straight and without twist, of tubular design. For removable mullions provide fastenings of non-ferrous bolts at bottom, with sleeves at head of frame for mullion to clip over.

I. Clearances: Provide and be responsible for proper clearances at metal frames, including for weatherstripping, soundstripping and smoke gasketing. Glass clearance shall be thickness of glass plus clearance each side (1/8 inch minimum exterior - 1/16 inch minimum interior), adjust for installation, glass thickness to allow for glazing and sealant. Where sealed double glazing is indicated, provide rebates minimum of 3/4 inch and provide 1/4 inch clearance at glass edges. Where units fit around concrete blocks (blocks built into frames) obtain actual dimensions of blocks being used to establish minimum clearances.

J. Stops: Set with countersunk or Jackson head screws.

K. Joinings: At frames with equal width jambs and head, neatly miter on face (except locations as at transom bars and at frames with large head members). Cope and butt stops. Weld length of entire joint, including face and flat intersections. Grind smooth, at other frames, provide same mitered joint wherever possible (at intersection of jamb-head or jamb-sill) and at other locations butt metal neatly and fully welded. All joints to be tight, neatly ground, puttied, and sanded smooth before priming.

L. Workmanship: Fabricate so no grind marks, hollow or other out-of-plane areas are visible. At joints of intermediate members (as mullions and transom bars), provide tight joining, neatly accomplished without holes, burned out spots, weld build up or other defacing work. Fill to close cracks and to preserve shapes. Tightly fit loose stops, to hairline joints.

M. Finish: Clean frames by degreasing process and apply thorough coating of baked-on primer, covering inside as well as outside surfaces. At galvanized frames, coat welds and other disrupted surface with zinc-rich paint containing not less than 90 percent zinc dust by weight.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
2. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.5 HOLLOW METAL DOORS

A. Provide to design indicated including: Flush panel doors, flush panel with cut-out as indicated, stile and rail type, stile and rail with door louver. Use galvanized steel at exterior doors.

B. Flush Doors: Reinforce, stiffen and sound deaden. Provide cut-outs for glass and louvers with stops as shown. Provide flush steel closure at top of exterior and interior doors and at bottom of exterior doors with drain holes in bottom closure. Provide seamless edge. Following door construction types are acceptable.

1. Exterior Doors (and Interior Reinforced Doors): 20 gage steel stiffener reinforced vertically 6 inches o.c. full height and width, spot welded 5 inches o.c. to both face sheets. Stiffeners welded together top and bottom. Insulate with 2-1/2 lb density mineral wool insulation.
2. Honeycomb Core Interior Doors (Typical): Impregnated Kraft honeycomb core completely filling inside of center panel and permanently laminated to inside face sheets.
3. Door Construction: Manufacturer's standard honeycomb, polyurethane foamed in place, unitized steel grid, vertical steel stiffeners, or rigid mineral fiber core with internal sound deadener on inside of face sheets where appropriate in accordance with SDI standards.

C. Seamless Vertical Edges: Construct doors with smooth flush surfaces, without visible joints or seams on exposed faces or stile edges. Interior and exterior door edge seams shall be full welded, except if polyurethane core is used for exterior, these doors shall have edges filled with body putty and ground smooth.

D. Exterior Hollow Metal Door Louvers: Fabricate louver units of 16-gage galvanized steel sheets with stationary, weatherproof Z-shaped blades and U-shaped frames, not less than 1-3/8 inch thick. Space louver blades not more than 1-1/2 inch o.c. Assemble units by welding. Provide insect screen on interior side of frame, consisting of 14 by 18 wire mesh in rigid, formed metal frame.

E. Typical Reinforcement: Provide as required for hardware items. For lock reinforcement, provide manufacturer's standard reinforcement. Provide 12 gage reinforcement for escutcheons or roses. centering clips to hold lock case in alignment. For door checks, provide 3/16 inch channel type reinforcements, 3-1/2 inch deep by 14 inches long, or as required. Hinge reinforcement minimum 7 gage by 1-1/2 inch by 9 inch bar. Weld reinforcing to door. Reinforce doors for surface items such as surface and semi-concealed closers, brackets, surface holders and door stops. Drilling and tapping installation of these surface items shall be done in field by hardware installer.

F. Special Reinforcing: At exterior doors, reinforce inside of door on hinge side with high frequency hinge preparation. Weld to door.

G. Hardware: Mortise, reinforce, drill and tap for hardware furnished under Section 087000 - Hardware, except drilling and tapping for surface door closers, door closer brackets and adjusters shall be done in field. Obtain templates from hardware supplier.

H. Finish: Provide prime coat finish on doors. Thoroughly clean off rust, grease and other impurities. Grind welds smooth, no marks shall show. Apply metallic filler as required to fill cracks and joints and to level any weld areas or similar imperfections. Sand filler coat smooth.

2.6 FASTENINGS

A. Provide fastenings, anchors and clips as required to secure hollow metal work in place. Provide Jackson head screws, or flatter. Dimple metal work to receive screw heads. Set stops and other non-structural fastenings with #6 Jackson head self-tapping screws.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine supporting structure and conditions under which hollow metal is to be installed. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install hollow metal in accordance with reviewed shop drawings and manufacturer's printed instructions. Securely fasten and anchor work in place without twists, warps, bulges or other unsatisfactory or defacing workmanship. Set hollow metal plumb, level, square to proper elevations, true to line and eye. Set clips and other anchors with Ramset "shot" anchors or drill in anchors as approved. Units and trim shall be fastened tightly together, with neat, uniform and tight joints.

B. Placing Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged.

1. In masonry construction, building-in of anchors is specified in Section 042000 - Unit Masonry. At in-place concrete or masonry construction, set frames and secure in place with masonry anchorage devices with bolt heads neatly filled with metallic putty, ground smooth and primed.
2. At acoustic rated metal stud and gypsum board partitions, install insulation within frames.
3. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
4. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
5. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Door Installation: Fit hollow metal doors accurately in their respective frames, within following clearances: Jambs and head 3/32 inch, meeting edges pair of doors 1/8 inch, sill where no threshold or carpet 1/4 inch above finished floor, sill at threshold 3/4 inch maximum above finished floor.

3.3 ADJUSTING AND CLEANING

A. Prime Coat Touch-Up: Immediately after installation, sand smooth rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

SECTION 083324
OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Standard overhead coiling doors, electric operated.
   2. Electrical wiring from disconnect to control station and door operator.

B. Related Sections:
   1. Section 055000 - Metal Fabrications: Steel framing and supports at overhead doors.
   2. Division 26 - Electrical: Conduit from disconnect to control station and door operator.

1.2 SYSTEM DESCRIPTION

A. Coiling Doors:
   1. (CD-1) Electric motor operated unit with manual override in case of power failure.

1.3 SUBMITTALS

A. Shop Drawings and Product Data: Submit in accordance with Section 013300. Indicate pertinent dimensioning, general construction, component connections and details, anchorage methods, hardware location, and installation details.

B. Submit samples of door finish in accordance with Section 013300.

C. Submit wiring diagrams for electric operated overhead coiling doors.

1.4 QUALITY ASSURANCE

A. Furnish each overhead coiling door as complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components.

B. Wind Loading: Design and reinforce overhead coiling doors to withstand 20 lb. per sq ft (85 mph) wind loading pressure unless otherwise indicated.

C. Fabricate unit to permit manual lifting of curtain for emergency exit after automatic closing, with curtain returning to closed position when released.

D. Operation-Cycle Requirements: Design overhead coiling door components and operator to operate for no less than 20,000 cycles.

E. Installer Qualifications: Engage experienced installer who is authorized representative of overhead coiling door manufacturer for both installation and maintenance of units required for this Project.

1.5 DELIVERY OF MATERIALS

A. Deliver doors in manufacturer's packaging complete with installation instructions.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer and Type:
   1. Door Type (CD-1): Model # FCM Motor operated, face of wall, steel rolling service doors by Cookson Company.

B. Other Acceptable Manufacturers: Cornell Iron Works, Wayne-Dalton, Lawrence, Apton, J.G. Wilson, Atlas Roll-Lite, Ceco/Windsor Door, Mahon Door, Overhead Door.

2.2 MATERIALS

A. Curtain: Minimum 22 gage galvanized steel, ASTM A526, galvanized with minimum 1.25 oz/sq ft coating in accordance with ASTM A525; ends of slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement; bottom fitted with angles to provide reinforcement and positive contact with floor when curtain is closed; labeled, in accordance with requirements indicated on drawings.

1. Slats: 2 inches wide by required length; slat profile No. 10.

B. Curtain Guides: Formed steel angles of required sizes and configurations.

C. Roller Shaft : Steel pipe and helical steel spring system capable of producing sufficient torque to assure easy operation of curtain from any position; adjustable spring tension.

D. Housing: Galvanized steel; internally reinforced to maintain rigidity and form.

E. Weatherstripping: Water and rot proof, resilient type; located along jamb edges, bottom of curtain, and within housing.

2.3 ELECTRIC OPERATOR

A. Electric Operator: UL approved in accordance with ANSI/UL 325; side mounted; volt as required by electrical service, single (three) phase, 60 hertz supply to electric motor as recommended by coiling door manufacturer; adjustable friction clutch, double shoe brake system actuated by independent full line voltage solenoid controlled by motor starter; fully enclosed positive gear driven limit switch; fully enclosed magnetic cross line reversing starter.

B. Control Station: Standard 3 button (open-close-stop) control, for each operator; 24 volt circuit; surface mounted.

1. Provide (2) 3 button control stations per door, locate as indicated on the drawings.

C. Safety Devices: Located at bottom of doors, full width; electromechanical type; wired to reverse door upon striking object; neoprene covered to provide weather seal.

2.4 FINISH

A. Galvanized steel with factory precoated powder coat with finish color coat in standard color as selected by the Architect.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install overhead coiling doors, with electric operators and controls, in accordance with reviewed shop drawings and manufacturer's instructions. Coordinate installation with electrical service and adjacent construction.

B. Fit, align, and adjust door assemblies level and plumb; provide smooth operation.

C. After completing installation, including work by other trades, lubricate, test, and adjust door to operate easily, free from warp, twist, or distortion.

D. Train Owner's maintenance personnel on procedures and schedules related to door operation, servicing, preventive maintenance, and procedures for resetting closing devices after activation.

END OF SECTION

SECTION 087100
DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Finish hardware for doors.
   2. Include screws, special screws, bolts, special bolts, expansion shields, and other accessory devices for complete operational application of hardware.

B. Related Sections:
   1. Section 081113 – Hollow Metal Doors and Frames.
   2. Division 26: Electrical.

1.2 GENERAL REQUIREMENTS

A. Provide items, articles, materials, operations and methods listed, mentioned or scheduled herein or on drawings, in quantities as required to complete project. Provide hardware that functions properly. Prior to furnishing hardware, advise Architect of items that will not operate properly, are improper for conditions, or will not remain permanently anchored.

1.3 SUBMITTALS

A. Hardware Schedule: Submit hardware schedule per Section 013300 in vertical format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Schedules, which do not comply, will be returned for correction before checking. Hardware schedule shall clearly indicate architect's hardware group and manufacturer of each item proposed. The schedule shall be reviewed prior to submission by a certified Architectural Hardware Consultant, who shall affix his or her seal attesting to the completeness and correctness of the schedule.
   1. Provide illustrations from manufacturers' catalogs and data in brochure form.
   2. Check specified hardware for suitability and adaptability to details and surrounding conditions. Indicate unsuitable or incompatible items and proposed substitutions in hardware schedule.
   3. Provide listing of manufacturer's template numbers for each item of hardware in hardware schedule.
   4. Furnish other Contractors and Subcontractors concerned with copies of final approved hardware schedule. Submit necessary templates and schedules as soon as possible to hollow metal, wood door, and aluminum door fabricators in accordance with schedule they require for fabrication.
   5. Samples: Lever design or finish sample: Provide 3 samples if requested by architect.

B. Wiring Diagrams: Provide complete and detailed system operation and elevation diagrams specially developed for each opening requiring electrified hardware, except openings where only magnetic hold-opens or door position switches are specified. Provide these diagrams with hardware schedule submittal for approval. Provide detailed wiring diagrams with hardware delivery to jobsite.

C. Installation Instructions: Provide manufacturer's written installation and adjustment instructions for finish hardware. Send installation instructions to site with hardware.

D. Templates: Submit templates and "reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.

E. Contract Closeout Submittals: Comply with Section 017800 including specific requirements indicated.
   1. Operating and maintenance manuals containing the following:
      a. Complete information in care, maintenance, and adjustment, and data on repair and replacement parts, and information on preservation of finishes.
      b. Catalog pages for each product.

c. Name, address, and phone number of local representative for each manufacturer.
d. Parts list for each product.

2. Copy of final approved hardware schedule, edited to reflect "As installed".
3. Copy of final keying schedule.
4. As installed "Wiring Diagrams" for each opening connected to power, both low voltage and 110 volts.
5. One complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

1.4 QUALITY ASSURANCE

A. Manufacturer: Obtain each type of hardware (ie. latch and locksets, hinges, closers) from single manufacturer, although several may be indicated as offering products complying with requirements.

B. Supplier: Recognized architectural finish hardware supplier, with warehousing facilities, who has been providing hardware for period of not less than 3 years. The supplier shall be, or employ, a certified Architectural Hardware Consultant (AHC), who is registered in the continuing education program as administered by the Door and Hardware Institute. The hardware schedule shall be prepared and signed by a certified AHC.

C. Installer: Firm with 3 years experience in installation of similar hardware to that required for this project, including specific requirements indicated.

D. Regulatory Label Requirements: Provide nationally recognized testing agency label or stamp on hardware for labeled openings. Where UL requirements conflict with drawings or specifications, hardware conforming to UL requirements shall be provided. Conflicts and proposed substitutions shall be clearly indicated in hardware schedule.

E. Accessibility Requirements: Doors to stairs (other than exit stairs), loading platforms, boiler rooms, stages and doors serving other hazardous locations shall have knurled or other similar approved marking of door lever handles or cross bars in accordance with local building codes.

F. Pre-Installation Conference: Prior to the installation of hardware, manufacturer's representatives for locksets, closers, and exit devices shall arrange and hold a jobsite meeting to instruct the installing contractor's personnel on the proper installation of their respective products. A letter of compliance, indicating when this meeting is held and who is in attendance, shall be sent to the Architect and Owner.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver hardware to jobsite in manufacturer's original packaging, marked to correspond with approved hardware schedule. Do not deliver hardware until suitable locked storage space is available. Check hardware against reviewed hardware schedule. Store hardware to protect against loss, theft or damage.

B. Deliver hardware required to be installed during fabrication of hollow metal, aluminum, wood, or stainless steel doors prepaid to manufacturer.

1.6 WARRANTY

A. Guarantee workmanship and material provided against defective manufacture. Repair or replace defective workmanship and material appearing within period of one year after Substantial Completion.

B. Provide ten year factory warranty on door closer body against defects in material and workmanship from date of occupancy of Project.

C. Replace shortages and incorrect items with correct material at no additional cost to Owner.

D. At completion of project, qualified factory representative shall inspect closer installations. After this inspection, letter shall be sent to Architect reporting on conditions, verifying that closers have been properly installed and adjusted.

PART 2 PRODUCTS

2.1 BUTTS AND HINGES

A. Acceptable Manufacturers and Types:

	McKINNEY	Hager	Stanley
Type 1 (hvy.wt. swing clear)	T4A3795	BB1262	FBB268
Type 2 (std.wt. ball-bearing)	TA2714	BB1279	FBB179
Type 3 (std.wt. non-ferrous)	TA2314	BB1191	FBB191
Type 4 (hvy.wt. ball-bearing)	T4A3786	BB1168	FBB168
Type 5 (hvy.wt. non-ferrous)	T4A3386	BB1199	FBB199

B. Application:

1. Exterior outswinging doors — Type 5 x NRP
2. Exterior inswinging doors and vestibule doors — Type 4
3. Interior doors with closers — Type 2 or 4
4. Interior doors over 36 inches wide — Type 4
5. Interior doors 36 inches or less without closer — Type 2
6. Provide NRP (non-removable pins) at out-swinging lockable doors.

C. Size:

1. 2-1/4 inch Doors — 5 inch by 5 inch
2. 1-3/4 inch Doors — 4-1/2 inch by 4-1/2 inch
3. 1-3/8 inch Doors — 3-1/3 inch by 3-1/2 inch

D. Quantity:

1. 2 - hinges per leaf for openings through 60 inches high.
2. 1 - additional hinge per leaf for each additional 30 inches in height or fraction thereof.
3. 4 - Dutch doors up to 90 inches in height.

E. Drill 5/32 inch hole and use No. 12, 1-1/4 inch steel threaded to the head wood screws for hinges on wood doors.

2.2 LOCKSETS – CYLINDRICAL RON – DO WE NEED TO SPEC 3 MFGR.?

A. Acceptable Manufacturer and Series: To match building standard.

Schlage
D - RHO

B. Provide lock functions specified in Hardware Groups, with following provisions:

1. Cylinders: Keyway - Primus cylinder. Provide without cylinder.
2. Backsets: 2-3/4 inches.
3. Strikes: Provide wrought boxes and strikes with proper lip length to protect trim but not to project more than 1/8 inch beyond trim, frame or inactive leaf. Where required, provide open back strike and protected to allow practical and secure operation.
4. ANSI functions – cylindrical locks.

Function	ANSI #
passage	F75
privacy	F75
office	F82
classroom	F84
storeroom	F86
Entrance	F109

C.

2.3 KEYING

A. Master key or Grand master key cylinders and key in groups, unless otherwise specified. Factory masterkey with manufacturer retaining permanent keying records.

B. Provide 6 masterkeys for each masterkey set. Provide 3 change keys for each lock. Provide 2 control keys for core removal. Stamp keys "DO NOT DUPLICATE."

C. Submit proposed keying schedule to Architect. If requested, meet with Owner and Architect to review schedule.

D. Provide construction masterkeying. Permanent cylinders/cores shall be installed upon completion of the project.

2.4 DOOR TRIM

A. Acceptable Manufacturers and Types:

	Trimco
Kickplate/bottom latch guard	PG8002

B. Kick Plates and Armor Plates: Minimum of 0.050 inch thick, beveled 4 edges.
   1. At single doors provide width 1-1/2 inch less than door width on stop side and one inch less than door width on face side.
   2. At pairs of doors provide width one inch less than door width on both sides.
   3. Kickplate height of 10 inches, armor plate height of 34 inches, unless otherwise indicated.

C. Edge Guards: Minimum .050" thick, stainless steel,
   1. Hiawatha type DES-1A/DES-2A x 34 inches high, or as noted in Hardware Groups.

2.5 DOOR CLOSERS

A. Acceptable Manufacturers and Types of Exposed Closers:

SARGENT	Norton	Yale	LCN
351/351-P10	7500/PR7500	4400/PR4400	4040/4040 EDA

B. Provide non-sized closers, adjustable to meet maximum opening force requirements of ADA.

C. Provide drop plates, brackets, or adapters for arms as required to suit details.

D. Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

E. Provide back-check for closers.

F. Provide mechanical holder arms where indicated.

G. Provide closers for doors as noted in Hardware Groups and, in addition, provide closers for labeled doors whether or not specifically noted in group.

H. Provide closers meeting the requirements of UL 10C positive pressure tests.

2.6 WALL STOPS AND HOLDERS

A. Acceptable Manufacturers and Types:

	Trimco	Ives	Burns
concave wall stop	1270WX	WS407CCV	575

2.7 PROVIDE 1270WX SERIES WALL STOP AS APPLICABLE, FOR EACH DOOR LEAF FASTENERS

A. Including, but not limited to, wood or machine screws, bolts, bolts, nuts, anchors, etc. of proper type, material, and finish required for installation of hardware.

B. Use phillips head for exposed screws. Do not use aluminum screws to attach hardware.

C. Provide self-tapping (TEC) screws for attachment of sweeps and stop-applied weatherstripping.

2.8 TYPICAL FINISHES AND MATERIALS

A. Finishes, unless otherwise specified:
   1. Butts: Outswinging Exterior Doors
      a. US32D (BHMA 630) on Stainless Steel
   2. Butts: Interior Doors and Inswinging Exterior Doors
      a. US32D (BHMA 630) on Stainless Steel
   3. Continuous Hinges:
      a. US28 (BHMA 628) on Aluminum
   4. Flush Bolts:
      a. US26D (BHMA 626) on Brass or Bronze
   5. Exit Devices:
      a. US32D (BHMA 630) on Stainless Steel
   6. Locks and Latches:
      a. US32D (BHMA 630) on Brass or Bronze
   7. Push Plates, Pulls and Push Bars:
      a. US32D (BHMA 630) on Stainless Steel
   8. Coordinators:
      a. USP (BHMA 600) on Steel
   9. Kick Plates, Armor Plates, and Edge Guards:
      a. US32D (BHMA 630) on Stainless Steel
   10. Overhead Stops and Holders:
      a. US26D (BHMA 626) on Brass or Bronze
   11. Closers: Surface mounted.
      a. Sprayed Aluminum Lacquer.
   12. Latch Protectors:
      a. US32D (BHMA 630) on Stainless Steel
   13. Miscellaneous Hardware:
      a. US26D (BHMA 626) on Brass or Bronze

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine doors, frames, and related items for conditions that would prevent the proper application of finish hardware. Do not proceed until defects are corrected.

3.2 INSTALLATION

A. Install finish hardware in accordance with reviewed hardware schedule and manufacturer's printed instructions. Prefit hardware before finish is applied, remove and reinstall after finish is completed. Install hardware so that parts operate smoothly, close tightly and do not rattle.

B. Installation of hardware shall comply with NFPA 80 and NFPA 101 requirements.

C. Set units level, plumb and true to line and location. Adjust and reinforce attachment to substrate as necessary for proper installation and operation.

D. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. For doors with door pulls and push plates, Install door pulls with through bolted fasteners countersunk and flush with door face. Then install push plates over countersunk through bolts so they are concealed by push plate.

3.3 FIELD QUALITY CONTROL

A. After installation has been completed, provide services of qualified hardware consultant to check Project to determine proper application of finish hardware according to schedule. Also check operation and adjustment of hardware items.

B. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.4 ADJUSTING AND CLEANING

A. At final completion, hardware shall be left clean and free from disfigurement. Make final adjustment to door closers and other items of hardware. Where hardware is found defective repair or replace or otherwise correct as directed.

B. Adjust door closers to meet opening force requirements of Uniform Federal Accessibility Standards.

C. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of space or area, return to work during week prior to acceptance or occupancy, and make final check and adjustment of hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors.

D. Instruct Owner's personnel in proper adjustment and maintenance of door hardware and hardware finishes.

E. Clean adjacent surfaces soiled by hardware installation.

3.5 PROTECTION

A. Provide for proper protection of items of hardware until Owner accepts Project as complete.

3.6 HARDWARE GROUPS AND MODIFIERS

A. The following schedule of Hardware Groups shall be considered a guide only, and the supplier is cautioned to refer to general conditions, special conditions, and the preamble to this section. It shall be the hardware supplier's responsibility to furnish all required hardware.

B. Refer to the door schedule for hardware group required at each door opening. Ignore hardware groups not used on the door schedule.

C. Hardware Group modifiers shown in the door schedule indicate a variation to the group:

"A" - Add armor plate to push side of door. (both leaves of pairs and both sides of double-acting doors) Omit kickplate if previously scheduled. Refer to Part 2 - DOOR TRIM.

“B” - Substitute swing-clear type hinges (Type 1). Refer to Part 2 - BUTTS AND HINGES.

"D" - Add delayed action feature to specified closer.

"E" - Add electric strike (fail-secure). Refer to Part 2 - ELECTRIC STRIKES. For pairs of doors without a mullion provide continuous current electric hinge. See electrical for voltage requirements. Connection by Electrical. Access control not included in Section 087000.

"G" - Add door edge guard to hinge and latch edges. (both leaves of pairs) Refer to Part 2 - DOOR TRIM.

"H" - Add mechanical holder feature for non-rated doors. (both leaves of pairs) Provide holder arm for closer or holder feature for overhead stop, unless noted otherwise.

"K" - Add kickplate to doors scheduled without closers or to pull side of doors scheduled with closers. Refer to Part 2 - DOOR TRIM.

"L" - Add lead lining to all mortise hardware, including roses. Substitute L147 pivot with ML19 intermediate pivots spaced at same intervals as hinges. Add door edge guards and kickplates if not previously scheduled.

"M" - Add wall-mounted electro-magnetic hold-open. (both leaves of pairs) Refer to Part 2 - MAGNETIC HOLDERS. If not applicable for the opening conditions, provide electronic closer/holder. (both leaves of pairs) Refer to Part 2 - CLOSER/HOLDERS. See electrical for voltage requirements. Connections *and wall-mounted release switch located behind doors* are by Electrical.

"N" - Substitute "non-ferrous" or stainless steel hardware for all exposed metals, including, but not limited to: hinges, locks, closers (SRI primer), stops, etc. and all screws, brackets, and fastening devices.

"P" - Add door position switch. (both leaves of pairs) Refer to Part 2 - DOOR POSITION SWITCHES.

"S" - Add sound gasket, threshold, and automatic door bottom. Refer to Part 2 - SOUND GASKETING.

"W" - Add weatherstrip, sweep(s), threshold, and rain drip. For pairs with fixed astragal by door supplier, furnish gasket strip similar to Pemko S88D. For pairs with both doors active, provide astragal similar to Pemko 18041_P for each leaf. Refer to Part 2 - THRESHOLDS and WEATHERSTRIPPING.
At aluminum doors add threshold and sweep(s) only – weatherstripping is provided by door manufacturer.

"X" – Omit kick plate, if indicated in hardware group.

3.7 HARDWARE GROUPS

GROUP 1 - Hardware by others

All Hardware by Door Supplier.

GROUP 36 - Public Entrance with closer

Hinges
1 each Lockset Public Entrance function
Function: Latchbolt retracted by lever either side unless outside lever is locked by key or by turning inside knob. Key outside retracts latchbolt. Deadlocking latchbolt.
1 each Closer
1 each Kickplate
1 each Stop

END OF SECTION

SECTION 088000
GLAZING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Monolithic vision glass.
      a. Tempered safety glass
   2. Accessories, glazing and setting materials.

B. Related Sections:
   1. Section 079000 – Joint Protection.
   2. Section 081113 – Hollow Metal doors and Frames: Glass stops and glazing gaskets.

1.2 DEFINITIONS

A. Manufacturer: A firm that produces primary glass or fabricated glass as defined in referenced glazing publications.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thicknesses indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thicknesses indicated, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
   1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
      a. Specified Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.4.2, "Analytic Procedure," based on mean roof heights above grade indicated on Drawings.
      b. Specified Design Snow Loads: As indicated, but not less than snow loads applicable to Project, required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7, "Snow Loads."
      c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
         1) Load Duration: 60 seconds or less.
      d. Maximum Lateral Deflection: For the following types of glass supported on all four edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
         1) For monolithic-glass lites heat treated to resist wind loads.
         2) For insulating glass.
         3) For laminated-glass lites.
      e. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.
      f. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F , ambient; 180 deg F, material surfaces.

1.4 APPLICABLE STANDARDS

A. Safety Glazing: Conform to Safety Standard for Architectural Glazing Materials (16 CFR 1201). Tempered glass and wire glass shall conform to requirements of ANSI Z97.1, with permanent label in accordance with statutes.

B. Insulating Glass: ASTM E773, Seal Durability of Sealed Insulating Glass Units and ASTM E774, Sealed Insulating Glass Units. Certification through Insulating Glass Certification Council, Class A level.

C. Flat Glass: ASTM C1036, Flat Glass. Flat Glass Marketing Association (FGMA) Glazing Manual.

D. Heat Treated Flat Glass: ASTM C1048, Heat Treated Flat Glass.

1.5 SUBMITTALS

A. Product Data: Provide for structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

B. Samples: Submit samples of sandblasted/frosted, spandrel, decorative and wire glass, and glazing sealant, for color selection and appearance acceptance.

C. Compatibility Certification: After testing and review, certify compatibility of materials in contact and in close proximity to glazing sealant materials.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).

B. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.

1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

C. Single Source Responsibility: Provide materials obtained from one source for each type of insulating glass and glazing product indicated.

D. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1.

1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.

1.7 PRODUCT HANDLING

A. Deliver and store glass and glazing in manufacturer's protective covering. Handle glass and glazing with care to prevent damage.

1.8 PROJECT/SITE CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).

1.9 GLASS WARRANTY

A. Warranty for Insulating Units: Warranty sealed insulating glass units for minimum period of ten (10) years, with manufacturer's replacement guarantee, covering as minimum: Defective or failure of seal; material vision obstruction as result of dust collection or film formation between panels or other similar failure and the following specific conditions:
   1. Reflective glass whose reflective coating cracks, peels or discolors shall be replaced at no charge (material only) for minimum ten (10) year period beginning on date of Substantial Completion.
   2. In addition to replacement of insulated units, provide removal and reinstallation of new units without cost to Owner during first five (5) years of guarantee.

B. Laminated Glass Warranty: Laminated glass that delaminates shall be replaced at no charge (material only) for minimum 5 years beginning on date of Substantial Completion.

C. Glazing installer shall coordinate glass and glazing installation with framing systems, and install glass and glazing in accordance with manufacturer's instructions, so that guarantee is maintained.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers for Glass Substrate:
   1. AFG Industries.
   2. ACH Float Glass Operations (Versalux)
   3. Guardian Industries.
   4. Pilkington.
   5. PPG Industries Glass Group.

B. Acceptable Fabricators for Insulated Glass Units:
   1. Any manufacturer/fabricator with "CBA" classification.

2.2 SINGLE GLASS

A. (GL-1) Clear Float Glass: 1/4 inch thickness; comply with ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select).
   1. (GL-1T) Clear Tempered Glass: 1/4 inch thickness; comply with ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), and further processed to comply with ASTM C1048, Kind FT (fully tempered).

2.3 LAMINATED MONOLITHIC GLASS

A. (GL-15) Laminated Clear Glass: 1/4 inch thick laminated glass, 2 layers of 1/8 inch clear glass laminated with 0.030 inch clear PVB inner layer. Edges ground smooth for exposed conditions.

2.4 ACCESSORIES

A. Setting Blocks: Neoprene, 80 to 90 shore "A" durometer hardness, chemically compatible with glazing sealant or compound, length as recommended by glass manufacturer.

B. Spacers and Shims: Neoprene, 40 to 50 shore "A" durometer hardness, chemically compatible with glazing sealant or compound, length as recommended by glass manufacturer.

C. Glazing Tape: Butyl or silicone preshimmed tape similar to Tremco 440 Tape.

2.5 INTERIOR GLAZING

A. Type and Manufacturer: Mono one-part acrylic-terpolymer sealant or Proglaze silicone sealant by Tremco, color as selected from manufacturers standard colors.

B. Other Acceptable Manufacturers: General Electric, DAP, PTI, Pecora.

C. Fire-Rated Glazing System: As recommended by fire-rated glass manufacturer.

D. Butt Glazing System: Tremco silicone structural "butt" glazing system, color as selected from manufacturer's standard range.

2.6 FABRICATION

A. Heat-Treated Float Glass: ASTM C 1048. Fabricate using horizontal roller heating process only. Roll wave distortion parallel to bottom edge of glass as installed. Deviation from flatness at any peak (peak to valley deviation): shall not exceed 0.003 inches in the center of a lite and shall not exceed 0.008 inches within 10.5 inches of the leading or trailing edge.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Verify glazing channels are free of burrs, irregularities, and debris.
   2. Verify glass is free of edge damage or face imperfections.
   3. Inspect door and frames to determine that frames, sash, and stops are set true and straight. Sash rabbets and stops shall be clean and dry at time of glazing.
   4. Do not proceed until unsatisfactory conditions have been corrected.

B. Beginning of installation means acceptance of substrate.

3.2 PREPARATION

A. Provide glass manufacturer's recommended edge clearances when sizing glass.

B. Remove protective coatings from surfaces to be glazed.

C. Clean glass and glazing surfaces to remove dust, oil, and contaminants, and wipe dry.

D. Verify measurements of sash and openings at Project.
   1. Dimensions shown or indicated are given only as a guide for estimating purposes, and actual size shall be determined by measurement of the actual openings. Accurately cut glass to fit openings with proper clearances and setting block height.

E. Coordinate with and check Shop Drawings furnished by other suppliers of Work affecting this Section to avoid field installation problems.

F. Before glazing metal sash, remove oil, lacquer, or other material to which the compound will not readily adhere or which will tend to delaminate from metal and cause a leak through the glazing seal.

3.3 INSTALLATION

A. Comply with glass fabricators recommendations.

B. Comply with Flat Glass Marketing Association (FGMA) Sealant Manual and FGMA Glazing Manual.

C. Glaze insulated units as recommended by glass and frame manufacturers.

D. Do not apply glazing materials at temperatures below manufacturer's recommendations or to damp or frosted surfaces. Apply glazing material according to the manufacturer's instructions using proper primers as required.

E. Set glass using neoprene setting blocks and spacers to insure proper edge clearance and uniform beads of compound. Clearances shall conform to FGMA Glazing Manual requirements. Center glass in glazing rabbets.
   1. Butt glazing requirements: Apply mildew resistant silicone sealant to flush depth of joint as indicated by sealant manufacturer.

F. Check openings to confirm proper clearance at perimeters and between glass and stops.

1. Clean surfaces of rabbet (including stops) and surface of glass which will come into contact with sealant. Use solvents and methods which insure clean, dry surfaces without film or foreign material when sealant is placed.

G. Remove and replace glazing beads carefully to avoid marking or defacing any portion of frame, sash, or fastenings.
   1. Set glass in full bed of glazing tape or sealant. Clean glazing material after stops are installed. Clean excess compound, etc. from glass after setting in conformance with glass manufacturer's recommendations.
   2. If recommended prime surfaces prior to glazing.

H. Set glass with reams (waves) running horizontally. Set glass with factory attached labels in place.

I. Setting Blocks: Place setting blocks at locations recommended by glass manufacturer, generally between 1/4 points and 6 inches from corner, except at glazed doors.
   1. At glazed doors, provide one block at sill, located 3 inches up from edge of glass at hinge side; one block at hinge side jamb, located 3 inches up from lower edge of glass; one block at head, located 3 inches from edge of glass at latch side of door; and, one block at jamb at lock side of door, located 3 inches down from edge of glass at top corner.
   2. Use blocks of length required to properly support glass. Offset approximately 1 inch from shims.

J. Glass Installation in Steel (Hollow Metal) Frames:
   1. Glaze frames using pre-shimmed tape on both sides. Firmly glaze in place with joints sealed, free of rattles.
   2. Set glass on setting blocks with a full bed of sealant or glazing tape.

K. Glazing Sealant: Along entire bottom edge of light, and up at least 6 inches at each jamb, gun in continuous full bed of sealant to fill voids.
   1. Fill entire space, full width of pane, full depth of glass, with sufficient sealant to form heel along inside face and edge of glass.
   2. At other edges (top and sides) gun in continuous heel bead of sealant along edges of glass perimeter to set stop against and into, acting as fill between glass and stop.
   3. Immediately after setting glass, at entire perimeter of glass, gun in sealant between stop and glass so space above spacer is completely filled, without voids.
   4. Place sealant flush with daylight edge of stops, with slight watershed at exterior. Provide straight, smooth surface meeting at opening corners with sharp intersection.
   5. Leave no sealant on exposed surfaces of stops and glass.

L. Apply structural sealant carefully in uniform thickness pushing bead ahead of nozzle and making sure that entire cavity is filled. Air pockets or voids along edges are not acceptable.
   1. Tool joint immediately after application.
   2. Tool neatly, forcing sealant into contact with joint sides, eliminating internal voids and insuring good substrate contact.
   3. Do not tool with soap or detergent solutions.
   4. Install silicone structural butt glazing system in accordance with manufacturer's printed instructions.

3.4 CLEANING

A. Remove surplus materials.

B. Final cleaning of glass by Contractor.

END OF SECTION

SECTION 089100
LOUVERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shop fabricated louvers and frames.
   2. Head and sill flashing to adjacent work.
   3. Bird screening
   4. Insulated blank off panels.
   5. Attachment hardware.

B. Related Sections:
   1. Division 23 - Mechanical: Attachment of ducting and blanking out unused louver area.
   2. Section 055000 - Metal Fabrications: Steel support framing.

1.2 REFERENCES

A. SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details and installation procedures.

1.3 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 013300. Clearly indicate, in large scale, profile of frame and installation details, relation to adjacent construction, flashing, blade configuration, connections to duct work, bird screens, and percentage of free air opening.

B. Samples: Submit samples of metal wall louver finish in accordance with Section 013300.

1.4 QUALITY ASSURANCE

A. General: Design and fabricate exterior wall louvers in accordance with AMCA Standard 500 and comply with AMCA Certified Ratings Program.

B. Free Area, Exterior Wall Louvers: Not less than 40 percent free area.

C. Water Penetration, Exterior Wall Louvers: Zero water penetration at 700 FPM through louver free area.

D. Air Pressure Drop, Exterior Wall Louvers: Not more than 0.10 inch of Water Gauge at 1000 FPM through louver free area.

E. SMACNA Standard: Comply with SMACNA Architectural Sheet Metal Manual recommendations for fabrication, construction details, and installation procedures.

1.5 PROTECTION

A. Protect louvers and finishes from damage during delivery and installation.

B. Protect adjacent surfaces, finishes and materials from damage during installation of louvers.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer and Type: Type 6774 formed galvanized metal drainable louvers by Airolite Company.

B. Other Acceptable Manufacturers: A. C. P., Inc., Airline Products, Airstream Products, Construction Specialties, Industrial Louvers, Louvers and Dampers, Cesco Products, Ruskin Manufacturing, Arrow United Industries, Commercial Air Products, Dowco, American Warming and Ventilating.

2.2 MATERIALS

A. Steel Sheet: ASTM A526; A527; hot rolled; G90 galvanized coating.

B. Steel Shapes: ASTM A36.

2.3 FABRICATION

A. Steel Louvers (LVR-1): Formed 20 gage blades 4 inches deep, spot welded to formed 16 gage channel frame blades fixed at 43 degree slope, with 44 percent free area.

B. Blank-off Panels: 26 gauge galvanized sheet metal panels, inner and outer layer with 2 inch rigid insulation core with perimeter gasket. Interior and exterior galvanized finish.

C. Bird Screen: 0.063 inch diameter galvanized steel wire 1/2 inch interwoven square mesh in galvanized steel frame.

D. Accessories: Exposed mullions, sill extensions, flashings, wall anchors, structural supplementary sub-framing.

2.4 FINISHES

A. Galvanized, unfinished.

PART 3 EXECUTION

3.1 PREPARATION

A. Take site dimensions affecting this work.

B. Ensure openings affecting this work are properly prepared and that flashings are correctly located to divert moisture to exterior.

3.2 INSTALLATION

A. Install louvers in openings properly aligned and level.

B. Secure louvers rigid with semi-concealed fasteners of noncorrosive metals to suit materials as being encountered.

C. Coordinate installation method with application of wall system and mechanical work.

D. Set and tie in to flashings to ensure diversion of moisture to exterior.

E. Install bird screens fixed to interior.

3.3 CLEANING

A. Periodically clean exposed surfaces of louvers, which are not protected by temporary covering, to remove fingerprints and soil during construction period; do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and mild soap or detergent not harmful to finishes. Rinse thoroughly and dry surface.

END OF SECTION

SECTION 099000
PAINTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Painting and finishing of new materials.
   2. Preparation of surfaces for painting and finishing.
   3. Repainting and refinishing of existing surfaces as indicated and as specified in Section 017329 - Cutting and Patching.
      a. Preparation of existing surfaces for repainting and refinishing.

B. Related Sections:
   1. Section 099600 – High Performance Coatings.

1.2 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.
   1. Material List: Provide inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
   2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing and applying each coating material proposed for use.
   3. Certification by manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

B. Samples: Submit paint and transparent finish samples in accordance with Section 013300, for color selection and finish acceptance.
   1. Paint Colors, Surface Treatments and Finishes: As selected by Architect. Submit three 8 inch by 10 inch samples to be reviewed for color and sheen. Architect reserves right to select color or finish from any manufacturer, herein specified, as necessary to achieve desired color or finish.

C. Schedule: For acceptance, submit 3 copies of complete schedule showing each product by number and brand name proposed to be used at each surface and location. Generally follow specified outline and list number of coats.

1.3 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide primers and undercoat paint produced by same manufacturer as finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

C. Applicator Qualifications: Engage experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with record of successful in-service performance.

D. Mock-up

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing or reducing.

B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45 degrees F in well ventilated area. Restrict storage to paint materials and related equipment.

C. Take precautionary measures to prevent fire hazards and spontaneous combustion. Comply with health and fire regulations.

1.5 PROJECT CONDITIONS

A. Environmental Requirements: Comply with manufacturer's recommendations as to environmental conditions under which painting and finishing can be applied. Do not apply finish in areas where dust is being generated.

B. Measure moisture content of surfaces using electronic moisture meter. Do not apply finishes unless moisture contents of surfaces are below following maximums:
   1. Plaster and Gypsum Wallboard: 12 percent.
   2. Masonry, Concrete and Concrete Block: 12 percent.
   3. Interior Wood: 15 percent.

C. Ensure surface temperature and surrounding air temperature is above 40 degrees F before applying finishes. Minimum application temperature for latex paints for interior work shall be 45 degrees F and 50 degrees F for exterior work. Minimum application temperature for transparent finish shall be 65 degrees F, or surface and air temperature shall be 5 degrees above dew point.

D. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F for 24 hours before, during and 48 hours after application of finishes.

E. Provide minimum 25 foot candles of lighting on surfaces to be finished.

1.6 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
   1. Quantity: Furnish Owner with extra paint materials in quantities indicated below:
      a. Interior, Paint: 1 gal. of each color applied.
      b. Exterior, Paint: 1 gal. of each color applied.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. National Manufacturers:
   1. Sherwin-Williams
   2. Glidden Professional/Devoe Coatings
   3. Benjamin Moore
   4. Mythic Paint
   5. PPG Industries
   6. Pittsburgh Paints

2.2 MATERIALS

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
   1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
      a. Products specified are by Sherwin-Williams (S-W), unless otherwise indicated, similar quality products of acceptable manufacturers may be furnished.
      b. Refer to Painting and Finishing Schedule at end of this Section.

1) Colors (PT): Paint Systems indicated in Schedule in Part 3
   (a) Refer to Schedule of Finishes for manufacturer and color selection.

C. Sheen: When one of following terms is used to denote specific sheen for coating listed, following index shall apply:
   1. Flat: Less than 15 units based on 85 degrees of sheen.
   2. Eggshell: 5 to 20 units based on 60 degrees of sheen.
   3. Satin/Low Lustre: 15 to 35 units based on 60 degrees of sheen.
   4. Semi-gloss: 30 to 65 units based on 60 degrees of sheen.
   5. Gloss: Above 65 units based on 60 degrees of sheen.

D. Paint Types and Colors: Refer to Material Identification Codes.

2.3 MIXING AND TINTING

A. Deliver paints ready-mixed to job site.

B. Job mixing and job tinting is not acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive paint and transparent finishes for conditions that would adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work. Do not proceed with surface preparation or coating application until conditions are suitable.

3.2 PREPARATION OF SURFACES

A. Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as specified, for each particular substrate condition.
   1. Remove mildew, by scrubbing with solution of detergent, bleach and warm water. Rinse with clean water and allow surface to dry completely.
   2. Remove surface contamination from aluminum surfaces requiring paint finish by steam, high pressure water or solvent washing. Apply etching primer or acid etch. Apply paint immediately if acid etching.
   3. Remove contamination from copper surfaces requiring paint finish by steam, high pressure water or solvent washing. Apply vinyl etch primer or acid etch. Apply paint immediately if acid etching.
   4. Provide barrier coats over incompatible primers or remove and reprime as required. Notify Architect in writing of anticipated problems in using specified coating systems with substrate primed by others.

B. Remove hardware, hardware accessories, plates, lighting fixtures, and similar items in-place and not to be finish painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items by workmen skilled in trades involved.

C. Clean surfaces to be painted before applying paint or surface treatment. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall in wet, newly painted surfaces.
   1. Remove dirt, oil, grease and sand if necessary to provide adhesion key, when asphalt, creosote or bituminous surfaces require paint finish. Apply compatible sealer or primer.
   2. Remove dirt, grease and oil from canvas and cotton insulated coverings.

D. Cementitious Materials: Prepare cementitious surfaces of concrete, concrete block and cement plaster to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application of paint.
   1. Remove contamination, acid etch and rinse new concrete floors with clear water. Ensure required acid alkali balance is achieved. Allow to thoroughly dry. Repeat procedure if necessary to achieve a medium sandpaper-like profile.
   2. Remove dirt, loose mortar, scale, powder and other foreign matter from concrete and concrete block surfaces which are to be painted or to receive clear seal. Remove oil and grease with solution of trisodium phosphate, rinse well and allow to thoroughly dry.
   3. Remove stains from concrete and concrete block surfaces caused by weathering of corroding metals with solution of sodium metasilicate after being thoroughly wetted with water. Allow to thoroughly dry.

E. Gypsum Wallboard: Remove contamination from gypsum wallboard surfaces and prime to show defects, if any. Paint after defects have been remedied.

F. Plaster Surfaces: Fill hairline cracks, small holes and imperfections on plaster surfaces with patching plaster. Smooth off to match adjacent surfaces. Wash and neutralize high alkali surfaces where they occur.

G. Galvanized Surfaces: Clean free of oil and surface contaminates with acceptable non-petroleum based solvent.

H. Ferrous Metals: Clean non-galvanized, ferrous surfaces that have not been shop-coated of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning, complying with Steel Structures Painting Council (SSPC)-SP3.
   1. Touch-up shop-applied prime coats which have damaged or bare areas. Wire-brush, solvent-clean, and touch-up with same primer as shop coat.
   2. Clean unprimed steel surfaces by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
   3. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. (Prime steel including shop primed steels.)

I. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off.
   1. Prime or seal wood required to be job painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood.
   2. When transparent finish is required, back-prime with one coat of same material as used for surface.
   3. Seal tops, bottoms and cut-outs of wood doors with coat of surface finish immediately upon delivery to job for field painted doors only.
   4. Scrape and clean small, dry, seasoned knots and apply thin coat of white shellac or other recommended knot sealer, before application of priming coat.
   5. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.
   6. Remove dust, grit and foreign matter from exterior wood siding which is to receive paint finish. Seal knots, pitch streak and sappy sections. Fill nail holes with exterior caulking compound after prime coat has been applied.
   7. Prior to finishing glue laminated beams, wash down surfaces with solvent and remove grease and dirt.

J. Existing Surfaces to be Repainted or Refinished: At areas indicated on the drawings, power wash concrete roof deck, steel roof trusses and other indicated surfaces to remove grease, oil, soil or other matter which will interfere with proper bond of new materials. Scrape and wire brush loose or flaking paint. Fill cracks, voids or other defects.

3.3 MATERIALS PREPARATION

A. Mix and prepare painting materials and transparent finish materials in accordance with manufacturer's directions.

B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in clean condition, free of foreign materials and residue.

C. Stir materials before application to produce mixture of uniform density, and as required during application of materials. Do not stir any film that may form on surface into material. Remove film and, if necessary, strain material before using.

3.4 APPLICATION

A. Do not apply to wet or damp surfaces.
   1. Wait at least 30 days before applying to new concrete or masonry.
      a. Test concrete for moisture content to verify manufacturer’s surface moisture requirements are met.
      b. Follow manufacturer’s procedures to apply appropriate coatings prior to 30 days.
   2. Wait until wood is fully dry after rain, fog or dew.
      a. Test wood for moisture content to verify manufacturer’s surface moisture requirements are met.

B. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
   1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
   2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
   3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
   4. Apply each coat at proper consistency.
      a. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.
   5. Each coat of paint shall be slightly darker than preceding coat unless otherwise approved by Architect.
   6. Provide finish coats which are compatible with prime paints used.

C. Do not apply succeeding coats until previous coat has completely dried. Sand between each enamel or varnish coat application with fine sandpaper, or rub surfaces with pumice stone where required to produce even, smooth surface in accordance with coating manufacturer's directions.
   1. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.

D. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive film thickness equivalent to that of flat surfaces.

E. Finish doors on tops, bottoms, and side edges same as exterior faces, unless otherwise indicated.

F. Film Thickness: Apply materials in accordance to paint manufacturer’s recommendations and spreading rates to provide total dry film thickness as recommended.
   1. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated
   2. Use precision instruments designed for measuring and evaluation wet and dry films of paints and coatings.
   3. Results measuring less than recommended thickness will require additional material application.
      a. Regardless of number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.
   4. Use of poor hiding colors may require application of additional coats in order to achieve proper coverage and hiding.

G. Apply first-coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

H. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat.

I. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure finish coat with no burn-through or other defects due to insufficient sealing.

J. Stipple Enamel Finish: Roll and redistribute paint to even and fine texture. Leave no evidence of rolling such as laps, irregularities in texture, skid marks, or other surface imperfections.

K. Transparent Finish: On exposed portions, use multiple coats to produce glass-smooth surface film continuity of even luster. Provide finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.

L. Repainting of Existing Surfaces: Where repainting of existing surfaces is required, repaint wall and ceiling surfaces in their entirety, patch or spot painting is not acceptable.

M. Paint surfaces behind movable equipment or furniture same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only.

N. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.5 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to mechanical and electrical documents with respect to field painting and finishing requirements. Painting of mechanical and electrical work is not required in pipe chases, tunnels, and mechanical rooms with unpainted walls.

B. Remove grilles, covers and access panels for mechanical and electrical systems from location and paint separately.

C. Finish paint primed equipment to color selected.

D. Prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating, or where they are not in finished space or room.

E. Paint interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers before installation of equipment with 1 coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.

F. Paint exposed piping, insulated piping and conduit occurring in finished areas. Color and texture to match adjacent surfaces.

G. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

3.6 CLEANING

A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered. Touch up and restore damaged or defaced painted areas.

B. During progress of work keep premises free from unnecessary accumulation of tools, equipment, surplus materials and debris. Remove at end of each workday.

C. Upon completion of work clean window glass and other paint-spattered surfaces and leave premises neat and clean, to satisfaction of Architect.

3.7 PROTECTION

A. Adequately cover or otherwise protect finished work of other trades and other surfaces from paint and damage. Repair damage as result of inadequate or unsuitable protection as acceptable to Architect.
   1. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

B. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

C. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items shall be carefully stored, cleaned and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

D. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

3.8 PAINTING AND FINISHING SCHEDULE (EXTERIOR)

A. Ferrous Metal Surfaces (Steel, Iron):
   1. Surfaces Included:
      a. Steel lintels, lintel plates, relieving angles.
      b. Roof ventilators, roof vents.
      c. Metal roof stacks.
      d. Exterior ferrous metal.
   2. Waterborne System (Low-VOC): (Waterborne Acrylic Gloss Enamel over Waterborne Metal Primer)
      a. Primer:
         1) 1 coat S-W DTM Acrylic Primer, B66W1.
      b. Finish:
         1) 2 coats S-W DTM Acrylic Coating Semi-Gloss, B66-200 Series.

3.9 PAINTING AND FINISHING SCHEDULE (INTERIOR)

A. Concrete Floor Traffic Stripes:
   1. Surfaces Included:
      a. Concrete floors subject to light/moderate traffic.
   2. Solventborne Slip-Resistant System: (Polyamide Epoxy Slip Resistant Epoxy Coating over Bonding Primer, not more than 100 g/L VOCs)
      a. Primer:
         1) 1 coat S-W Macropoxy 646-100, B58-600 Series.
      b. Finish:
         1) 1 coat S-W Macropoxy 646-100, B58-600 Series with Sharkgrip Slip Reistant Additive.

B. Unit Masonry Surfaces:
   1. Surfaces Included:
      a. Walls.
   2. Waterborne Zero VOC, Low Odor System: (Zero VOC, Low Odor Acrylic Finish over Latex Block Filler, not less than 35 percent solids, ammonia free coating)
      a. Block Filler:
         1) 1 coat S-W Preprite Block Filler, B25W25.
      b. Finish:
         1) 2 coats S-W ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series..

C. Ferrous and Non-Ferrous Metal Surfaces: (Other than ceilings)
   1. Surfaces Included:
      a. Hollow metal doors and frames.
      b. Overhead coiling door frames.
      c. Ladders and railings.

d. Bollards
e. Pre-painted surfaces.
f. Prime painted hardware.
g. Radiator, convector and other heating unit covers.
h. Uninsulated piping and ductwork.
i. Metal access panels.
j. Metal louvers and grilles.
k. Electric panels (over factory finish).
l. Fire horns.
m. Metal supports for counters, benches and shelves.
n. Exposed and miscellaneous metals.
o. Other exposed to view interior ferrous metals not factory finished.

2. Waterborne Zero VOC, Low Odor System: (Zero VOC, Low Odor Acrylic over Waterborne Metal Primer - not more than 50 grams VOC's per liter, not less than 35 percent solids, ammonia free coating)
   a. Primer:
      1) 1 coat S-W DTM Acrylic Primer, B66W1.
   b. Finish:
      1) 2 coats S-W ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series.

3.10 SPECIAL SURFACES

A. Ferrous and Non-Ferrous Metal Surfaces: (Ceilings)
   1. Surfaces Included:
      a. Bar joist, decking and supports.
      b. Galvanized ductwork
      c. Exposed metal at ceiling.
   2. Waterborne Systems: (Waterborne Dryfall over Waterborne Metal Primer)
      Primer: (touch-up if pre-primed)
      1) 1 coat 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
      b. Finish:
      1) 1 coat S-W Waterborne Acrylic Dry Fall, B42W2.

B. Insulated items in rooms with painted walls:
   1. Surfaces Included:
      a. Piping, ducts, tanks, and equipment.
   2. Waterborne System: (Premium Quality Acrylic Latex finish over -Acrylic Primer)
      a. Primer:
         1) 1 coat S-W Moisture Vapor Barrier Primer, B72W1.
      b. Finish:
         1) 2 coats S-W ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-2600 Series.

C. Black Enamel Finish:
   1. Surfaces Included:
      a. Duct throats for visible distance but not less than approximately 24 inches behind supply or return air grilles, registers, louvers.
      b. Wood blocking exposed at reveals.
   2. Water Based Systems (Low-VOC): (Acrylic Latex Finish)
      a. Finish:
         1) 1 coat S-W ProMar 400 Latex Flat Black, B30W400 Series.

3.11 REPAINTING OF EXISTING SURFACES

A. Existing Surfaces:
   1. Surfaces Included:
      a. Existing surfaces where indicated to be repainted.
      b. Existing metal lockers (casework) (metal toilet compartments) where indicated to be repainted.
   2. (Low-VOC) Latex System:
      a. Primer/Finish:
         1) 2 coats paint similar to type listed above.

END OF SECTION

SECTION 101423
PANEL SIGNAGE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Illuminated panel sign.

B. Related Requirements:
   1. Division 26 - Electrical.

1.2 DEFINITIONS

A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For panel signs.
   1. Include fabrication and installation details and attachments to other work.
   2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
   3. Show message list, typestyles, graphic elements, and layout for the sign at least half size .
   4. Show locations of electrical service connections.
   5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
   1. Include representative Samples of available typestyles and graphic symbols.
   2. Paint vinyl colors.

D. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

E. Delegated-Design Submittal:
   1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer, licensed in Wisconsin, responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Deterioration of finishes beyond normal weathering.
      b. Deterioration of embedded graphic image.
      c. Separation or delamination of sheet materials and components.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of illuminated panel sign withstand design loads as indicated on Drawings.

B. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F , ambient; 180 deg F , material surfaces.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SIGNS

A. Basis-of-Design Product: Subject to compliance with requirements, provide internally illuminated panel sign as indicated on the drawings, as manufactured by Poblocki Sign Company, LLC or comparable product by one of the following:
   1. ASI Sign Systems, Inc.
   2. Best Sign Systems Inc.
   3. Clarke Systems.
   4. Diskey Sign Company.
   5. Mohawk Sign Systems.
   6. Nelson-Harkins Industries.
   7. Michael's Signs.

B. Panel Sign (SIGN-1) Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
   1. Illuminated Panel Sign: Backlighted construction with high-output fluorescent tube lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from sign surfaces as needed to illuminate evenly.
      a. Power: 120 V, 60 Hz, 1 phase, 15 A.
      b. Weeps: Provide weep holes to drain water at lowest part of exterior signs. Equip weeps with permanent baffles to block light leakage without inhibiting drainage.
   2. Panel construction: 0.125 inch thick sheet aluminum, attached to aluminum angle frame with concealed fasteners.
   3. Routed graphics for "City of Milwaukee" with 3/16 inch thick white acrylic inserts for backlighting.
   4. City logo: Window cut out with die cut vinyl applied to 3/16 inch thick white acrylic for backlighting.

5. Compressed Natural Gas: Window cut out with 3 color die cut vinyl applied to 3/16 inch thick white acrylic for backlighting.
6. Price Display: Premanufactured LED digital display; Fuellight Petroleum Displays, Model No. FL-2000-20-NA-DI, Size: 1 foot 4 inches by 2 foot 1 inch with Digit Height: 12 inches.
   a. Provide (1) wireless, hand held, remote for changing fuel price.
7. Street Adress: FCO Painted: Matt White.
8. Aluminum Paint: Matthews
   a. Painted Finish and Graphics: Manufacturer's standard, factory-applied acrylic polyurethane in color as selected by Architect from manufacturer's full range.
   b. Overcoat: Manufacturer's standard baked-on clear coating]
9. Flatness Tolerance: Sign panel shall remain flat or uniformly curved under installed conditions as indicated and within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner.

2.3 PANEL-SIGN MATERIALS

A. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Steel Materials:
   1. Steel Members Fabricated from Plate or Bar Stock: ASTM A 529/A 529M or ASTM A 572/A 572M, 42,000-psi minimum yield strength.
   2. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.

D. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF.

E. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated and suitable for exterior applications.

F. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
   1. Use concealed fasteners and anchors unless indicated to be exposed.
   2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
   3. Exposed Metal-Fastener Components, General:
      a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
      b. Fastener Heads: For nonstructural connections, use screws and bolts with tamper-resistant spanner-head slots unless otherwise indicated.
   4. Sign Mounting Fasteners:
      a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
      b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
   5. Inserts: Furnish inserts to be set by other trades into concrete or masonry work.

B. Adhesives: As recommended by sign manufacturer and with a VOC content of 70 > g/L or less for adhesives used inside the weatherproofing system and applied on-site when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Adhesives: As recommended by sign manufacturer and that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

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

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
   1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
   2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
   3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
   4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
   5. Internally brace signs for stability and for securing fasteners.
   6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Subsurface-Applied Graphics: Apply graphics to back face of white face-sheet material to produce precisely formed image. Image shall be free of rough edges.

C. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, and prepare for coating according to coating manufacturer's written instructions.
   1. For Baked-Enamel or Powder-Coat Finish: After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

B. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils .

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that anchor inserts are correctly sized and located to accommodate signs.

D. Verify that electrical service is correctly sized and located to accommodate signs.

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

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION

SECTION 133422
PRE-ENGINEERED METAL CANOPIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Freestanding, pre-engineered metal canopies, including concrete foundation, steel framing, metal roof, roof drains and leaders, fascia components, and metal ceiling and accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide pre-engineered canopies complete, including foundation, electrical and lighting, capable of withstanding effects of gravity loads and following loads and stresses within limits, and under conditions indicated for specific location where Canopy will be installed:
   1. Uniform pressure as indicated on drawings – minimum design wind load per ASCE 7, CH.6.
   2. Snow load as indicated on drawings – minimum design snow load per ASCE 7, CH.7.
   3. Seismic performance – minimum design seismic criteria per ASCE 7, CH.11 – 13.

B. Thermal Movements: Provide pre-engineered canopies that allow for thermal movements resulting from following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

1.3 SUBMITTALS

A. General: Submit under provisions of Section 013300 – Submittal Procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.

C. Shop Drawings: Submit shop drawings. Include plans, elevations, sections, details, and attachments to other work.

D. Samples:
   1. Submit samples for initial color selection. Submit samples of each specified finish. Submit samples in form of manufacturer's color charts showing full range of colors and finishes available. Where finishes involve normal color variations, include samples showing full range of variations expected.
   2. Submit samples for verification purposes. Samples shall be submitted prior to installation.

E. Certificates: Submit product certificates signed by manufacturer certifying material compliance with specified performance characteristics and criteria, and physical requirements.

F. Warranty Data: Submit warranty documents specified herein.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in engineering and manufacturing pre-engineered canopies, with minimum documented experience of twenty years and with quality assurance program utilizing quality inspection for each system.

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

1. Welding shall be in accordance with AWS D1.1 (with E70XX electrodes).
2. Structural shop welding shall be done by certified welders.
3. Steel shop connections shall be welded and field connections shall be bolted, unless otherwise noted on Drawings. Shop welds may be changed to field welds with approval of project engineer.
4. Slag shall be cleaned from welds and inspected. Steel shall be painted with red oxide rust-inhibitive primer.

C. Electrical Components, Devices and Accessories: Listed and labeled as defined in NEC, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Source Limitations: Obtain pre-engineered metal canopy through one source from single manufacturer who shall manufacture and install canopy.

E. Product Options:

1. Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
2. Drawings indicate size, profiles, and dimensional requirements of pre-engineered metal canopies and are based on specific system indicated. Refer to Section 016210. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

F. Coordination:

1. Contractor shall conduct site meetings to verify project requirements, substrate conditions, utility connections, manufacturer's drawings, and installation instructions. Comply with Division 01 Section on project meetings.
2. Contractor shall prepare for and pour concrete footers for pre-engineered metal canopies. Manufacturer shall furnish recommended footing drawings and prints and rebar details for concrete footings, as well as provide anchor bolts to be embedded in concrete footer. Such items shall be delivered to project site in time for installation.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect all components and accessories from corrosion, deformation, damage and deterioration when stored at job site. Keep materials free from dirt and foreign matter.

1.6 PROJECT CONDITIONS

A. Field Measurements: Contractor shall verify location and elevation of footings relative to finished grade, columns, and other construction contiguous with pre-engineered metal canopies by field measurements before fabrication, and indicate measurements on shop drawings.

1. Established Dimensions: Contractor shall, where field measurements cannot be made without delaying work, establish dimensions and proceed with fabricating metal canopies without field measurements. Contractor is responsible to coordinate footer locations and elevations with any interferences with, or attachments to, abutting structures.

1.7 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of Contract Documents, and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

B. Special Warranty of Roof Panel Finishes: Written warranty, signed by Manufacturer, agreeing to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes

within specified warranty period. Deterioration of finish includes, but is not limited to, color fade, chalking, cracking, peeling, and loss of film integrity.

1. Warranty Period for Roof Panels: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Arning Companies, Cassville, MO.

B. Austin Mohawk and Company, Inc.

C. Jimco Sales and Manufacturing.

2.2 MATERIALS

A. Structural Steel:

1. Material and work shall conform to latest AISC 360.
2. Wide flange I-beam shall conform to ASTM A 572/A 572M GR.50, Fy = 50 ksi. Other rolled sections shall conform to ASTM A 36/A 36M, Fy = 36 ksi.
3. Square and rectangular tubing shall conform to ASTM A 500/A 500M, Grade B, Fy = 46 ksi.
4. Plate steel shall conform to ASTM A 36/A 36/M, Fy = 36 ksi.
5. Structural steel shall be painted with rust-inhibitive (red oxide) primer (std).
6. Structural steel shall be hot-dip-galvanized.

B. Sheet Metal:

1. Decking: 3 inches (76 mm) by 16 inches (406 mm) by 20 gage smooth white, ASTM A.
2. Center and Tapered Gutter: 24 gage hot-dip galvanized steel baked enamel finish.
3. Perimeter Gutter: 20 gage hot-dip galvanized steel baked enamel finish.
4. Internal Downspout: 3 inches (76 mm) diameter PVC.
5. External Downspouts: 3 inches (76 mm) by 4 inches (102 mm) by 24 gage hot-dip galvanized steel with baked enamel finish.
6. Manufacturer shall be capable of providing seamless gutter profiles up to 40 feet (12 m) in length.

C. Concrete Foundation:

1. Minimum 28 day compressive strength of 3000 psi. Cast-in-place concrete shall conform to Section 033000.

2.3 PRE-ENGINEERED METAL CANOPY

A. General: Provide complete, integrated set of manufacturer's standard fixed base design canopy components, wherein steel framing system uses stacked I-Beam construction, transferring moment to concrete footing without requiring rigid connection between steel frame members. Beam arrangements allow for cantilever design, which can bring columns from perimeter of structure to inner protected zones between drive lanes. These mutually dependent components form pre-engineered canopy, ready for construction on project site. Pre-engineered metal canopy will be designed to meet all site structural wind, snow and seismic requirements.

B. Canopy Fascia:

1. Aluminum Composite Panel (ACM): Fluorocarbon paint finish, masked on one side; shall be warranted for 20 years, depending on color and finish.

C. Canopy Finishes: Comply with NAAMM MFM for recommendations for applying and designating finishes.

1. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of range of approved samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable, if they are within range of approved samples and are assembled or installed to minimize contrast.

D. Fabrication: Fabricate pre-engineered canopies completely in factory.

2.4 FOUNDATION DESIGN

A. Assume 1500 psf bearing capacity. To be field-verified prior to design of canopy foundation.

2.5 LED CANOPY LIGHTING FIXTURES AND LED DRIVERS

A. Manufacturer:
   1. BetaLED, a division of Ruud Lighting, Sturtevant, WI, phone 800-236-6800, www.BetaLED.com.

B. Fixtures:
   1. BetaLED Catalog No. CAN EDG PS DM 14 C-UL WH P.
   2. Quantity of Fixtures:
      a. Minimum of six (6) fixtures with LED drivers for Northwest Garage Public Fueling Island Canopy Shall be provided to ensure adequate lighting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which work is to be installed, and notify Contractor, in writing, with copy to Owner and Architect, of any conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
   1. Examine supporting foundations for compliance with manufacturer's requirements, including installation tolerances and other conditions affecting performance of support members.
   2. Check installed anchor bolts for accuracy. Verify that bearing surfaces are ready to receive the work.
   3. Verify the rough-in of required mechanical and electrical services prior to placement of the structure.
   4. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
   5. Beginning of work shall indicate acceptance of areas and conditions as satisfactory by Installer.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces, using methods recommended by manufacturer for achieving best result for substrate under project conditions.

3.3 INSTALLATION

A. Work area shall be required extending 10 feet (3 m) beyond buildings and canopies in all directions to extent practical. Work area shall be flat and comprised of hard-packed soil or gravel, asphalt or concrete, and free of open excavation, debris, construction equipment and construction workers. Additional flat work space minimum of 25 feet (7.6m) by 25 feet (7.6m), or as practical, shall be provided adjacent to canopy and/or building for unloading and storing materials. Site should meet OSHA guidelines to allow lift equipment and scaffolding to maneuver in work area.

B. Set pre-engineered metal canopy plumb and aligned. Level base plates true to plane with full bearing on concrete bases.

C. Fasten pre-engineered metal canopy columns to anchor bolts and/or foundation bolts.

D. Provide anchor bolts as follows:
   1. Anchor bolts or foundation bolts will be set by Owner in accordance with approved site-specific drawings. They must not vary from size and dimensions shown on erection drawings. Use of plywood template is recommended. Remove template prior to column erection.
   2. Anchor bolts shall conform to ASTM A 307, and shall have minimum of 7 inches (178 mm) of exposed thread and 23 inches (584 mm) minimum embedment, with 1-1/4 inch (32 mm) nut and washer as embedment end.

3. Shrinkage-resistant grout shall be ASTM C 1107, factory-packaged, aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and 30 minutes working time installed by Contractor.

E. Provide bolted connections as follows:
   1. Structural erection bolts shall conform to ASTM A 325/A 325M.
   2. Minimum diameter of 3/4-inch (19 mm) erection bolts shall be used for cross beam-to-column connections, and minimum of 5/8 inch (16 mm) diameter bolts for all other connections.
   3. Drilled holes in structural steel shall be deburred.
   4. Flat structural washers (minimum of one) shall be used on bolted connections.
   5. Bolts shall be tightened to snug tight per latest RCSC specifications, unless otherwise specified.

F. Provide screws as follows:
   1. Fastening shall be performed per installation prints provided by manufacturer.
   2. Installation screws shall be furnished with electrode deposited cadmium coating unless otherwise noted.
   3. Self-drilling and self-tapping screws shall have sufficient cut-point and 1/2-inch (13 mm) outside diameter dished metal-backed neoprene washer to be used in water-sealing applications.

G. Provide pedestrian protection and warnings during construction that comply with local, federal, and OSHA codes.

H. Prior to steel erection of any kind, Contractor shall grade, backfill and otherwise prepare jobsite to allow for rolling scaffold and ensure safe working conditions, including removal or relocation of overhead power lines.

I. Any grade or elevation situations that deviate from approved manufacturer's plans shall be conveyed to manufacturer prior to fabrication.

J. All anchor bolts and/or leveling plates shall be set within 1/4 inch (6 mm) tolerance on layout and grade level.

K. Temporary electrical power shall be provided.

L. Connect electrical power service to power distribution system according to requirements specified in Division 26 – Electrical.

M. Dumpster for trash and debris shall be provided by Contractor.

3.4 ADJUSTING AND CLEANING

A. After completing installation, inspect exposed finishes and repair damaged finishes.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch up, repair, or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 220500
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Excavating and backfilling for pipe trenches.
   2. Piping materials and installation instructions common to most piping systems.
   3. Transition fittings.
   4. Dielectric fittings.
   5. Grout.
   6. Plumbing demolition.
   7. Equipment installation requirements common to equipment sections.
   8. Painting and finishing.
   9. Concrete bases.
   10. Supports and anchorages.

1.2 BASIS-OF-DESIGN

A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufacturers listed in the specification other than the basis-of design manufacturer are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

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

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.

B. Welding certificates.

C. Equipment Startup Reports.

D. Coordination Drawings: Submit one copy for the engineers use. Division 22 coordination drawings will not be returned.

1. Detail major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
   a. Planned piping layout, including valve and specialty locations and valve-stem movement.
   b. Clearances for installing and maintaining insulation.
   c. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
   d. Equipment and accessory service connections and support details
   e. Exterior wall and foundation penetrations.
   f. Fire- and smoke-rated wall and floor penetration.
   g. Sizes and locations of required concrete equipment curbs and bases.
   h. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
   i. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
   j. Access door and panel locations.

1.5 QUALITY ASSURANCE

A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. Equipment Substitutions: Equipment of greater capacity or of greater physical size or weight may be furnished provided such proposed equipment is approved in writing. Approval will require that any necessary structural modifications are made, any connecting mechanical and electrical services are increased, and if accommodations can be made in the allocated space. No additional costs will be approved for any changes necessary to provide the larger equipment. Refer to Division 1 Section “Product Options and Substitutions.”

F. Pre-excavation Conference: Conduct conference at Project site concerning pipe and duct trenching and backfilling to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

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

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

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate plumbing equipment installation with other building components.

E. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

F. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate connection of plumbing equipment and systems with building electrical systems.

1.8 GUIDELINES, CODES AND STANDARDS

A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.

B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Company
      b. Dresser Industries, Incorporated; DMD Division
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Division
      d. JCM Industries.
      e. Smith-Blair, Incorporated
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics, Incorporated.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO Incorporated.
      b. NIBCO, Incorporated; Chemtrol Division.

E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Company.
      b. Fernco, Incorporated.
      c. Mission Rubber Company.
      d. Plastic Oddities, Incorporated.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Epco Sales, Incorporated.
      d. Watts Industries, Incorporated; Water Products Division.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Advance Products & Systems, Incorporated.
      b. Calpico, Incorporated.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Incorporated.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Calpico, Incorporated.
      b. Lochinvar Corporation.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corporation.
      b. Precision Plumbing Products, Incorporated.
      c. Sioux Chief Manufacturing Company, Incorporated.
      d. Victaulic Company of America.

2.6 CONCRETE BASES

A. Refer to Division 03 Section "Cast-in-Place Concrete” or "Miscellaneous Cast-in-Place Concrete."

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 TRENCHING AND BACKFILLING

A. Refer to Division 31 Section “Building Trenching and Backfilling” for trenching and backfilling within the building.

3.2 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Verify final equipment locations for roughing-in.

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

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

J. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Non-pressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.

K. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

L. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

M. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

N. PEX Piping Joints: Join according to ASTM F 1807.

O. Steel-Piping Grooved Joints: Roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

P. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in steel piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric nipple fittings to connect piping materials of dissimilar metals.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install plumbing equipment according to the equipment manufacturer’s installation instructions and as indicated on the drawings. Resolve conflicting instructions, with the architect before mounting equipment.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

F. Refer to equipment shop drawings for rough-in locations; do not scale drawings.

3.7 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

A. Concrete Bases and Curbs: Cast-in-place concrete bases and curbs are specified in Division 03 Section "Cast-in-Place Concrete" or Miscellaneous Cast-in-Place Concrete."

1. Provide scaled layouts of bases and curbs with sizes and locations dimensioned to concrete walls and columns.
2. Determine base and curb sizes and locations based on "Accepted" equipment shop drawings. Base and curb sizes shall not be scaled from the Drawings.
3. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic requirements at Project.

B. Construction Details: Refer to Architectural Details for base and curb construction types. If not indicated, construct as follows:

1. Provide concrete bases sized 4 inches larger in both directions than the supported equipment.
2. Provide 4-inch high curbs and bases with finished edges, unless otherwise indicated.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
8. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete" or "Miscellaneous Cast-in-Place Concrete."

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.11 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.12 SEALANTS

A. Comply with joint-sealant materials and applications specified in Section 078400 “Firestopping,” Section 078443 “Fire-resistant Joint Sealants,” Section 079000 “Joint Protection,” and Section 092900 “Gypsum Board: Acoustical Sealants.”

END OF SECTION

SECTION 220517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Sleeve-seal fittings.
   5. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Smith, Jay R. Manufacturing. Company (www.jrsmith.com)
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group. (www.**zurn**.com)

F. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Incorporated (www.apsonline.com)
   2. CALPICO, Incorporated (www.calpicoinc.com)
   3. Metraflex Company (The). (www.metraflex.com)
   4. Pipeline Seal and Insulator, Incorporated (www.pipelineseal.com)
   5. Proco Products, Incorporated (www.procoproducts.com)

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

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

1. Presealed Systems. (ps.holdrite.com)

B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

F. Acoustical Interior Wall Penetrations: Maintain indicated STC rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with acoustical sealant materials.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller than NPS 6 Sleeve-seal fittings.
      b. Piping NPS 6 Galvanized-steel-pipe sleeves.
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller than NPS 6 Galvanized-steel-pipe sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   4. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
   5. Interior Partitions:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves

END OF SECTION

SECTION 220518
ESCUTCHEONS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.2 ACTION SUBMITTALS

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

PART 2 PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

2. Escutcheons for Existing Piping:
    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
    f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
    1. New Piping: One-piece, floor-plate type.
    2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 220523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:
   1. Copper-alloy ball valves.
   2. Ferrous-alloy butterfly valves.
   3. Bronze check valves.
   4. Gray-iron swing check valves.
   5. Spring-loaded, lift-disc check valves.
   6. Bronze globe valves.
   7. Cast-iron globe valves.
   8. Chainwheel actuators.

B. Related Sections include the following:
   1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and charts.
   3. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.2 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NBR: Acrylonitrile-butadiene rubber.
   4. PTFE: Polytetrafluoroethylene plastic.
   5. TFE: Tetrafluoroethylene plastic.

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.4 QUALITY ASSURANCE

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 3 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 4 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive: For quarter-turn valves NPS 8 and larger.
3. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

J. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves. Do not use solder joint ball valves.

K. Threaded: With threads according to ASME B1.20.1.

L. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:
   a. Conbraco Industries, Incorporated; Apollo Division
   b. Crane Company; Crane Valve Group.
   c. Grinnell Corporation.
   d. Hammond Valve.
   e. Jamesbury, Incorporated
   f. Jomar International, LTD.
   g. Legend Valve & Fitting, Incorporated
   h. Milwaukee Valve Company.
   i. Nexus Valve Specialties.
   j. NIBCO Incorporated
   k. Watts Industries, Incorporated; Water Products Division

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Threaded Bronze body with standard-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem. Example: Conbraco #70-100-03.

2.4 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:

1. Single-Flange, Ferrous-Alloy Butterfly Valves:
   a. American Valve, Incorporated
   b. Bray International, Incorporated
   c. Cooper Cameron Corporation; Cooper Cameron Valves Division
   d. Crane Company; Crane Valve Group.
   e. Dover Corporation; Dover Resources Company; Norriseal Division
   f. General Signal; DeZurik Unit.
   g. Grinnell Corporation.
   h. Hammond Valve.
   i. Kitz Corporation of America.
   j. Legend Valve & Fitting, Incorporated
   k. Metraflex Company
   l. Milwaukee Valve Company.
   m. Mueller Steam Specialty.
   n. NIBCO INC.
   o. Process Development & Control.
   p. Red-White Valve Corporation
   q. Techno Corporation
   r. Tyco International, Ltd.; Tyco Valves & Controls.
   s. Watts Industries, Incorporated; Water Products Division
2. Flanged, Ferrous-Alloy Butterfly Valves:
   a. Bray International, Incorporated
   b. Cooper Cameron Corporation; Cooper Cameron Valves Division
   c. Grinnell Corporation.
   d. Mueller Steam Specialty.
   e. Tyco International, Ltd.; Tyco Valves & Controls.
3. Grooved-End, Ductile-Iron Butterfly Valves:
   a. Grinnell Corporation.
   b. Hammond Valve.
   c. McWane, Incorporated; Kennedy Valve Division
   d. Milwaukee Valve Company.
   e. Mueller Steam Specialty.
   f. NIBCO INC.
   g. Victaulic Company of America.

B. Single-Flange, 200-psig CWP Rating, Ferrous-Alloy Butterfly Valve MSS-SP25: Lug type with one-piece stainless steel stem, EPDM liner, and aluminum bronze disc. Example: NIBCO #LD 2000.

C. Grooved-end, 300-psig CWP Rating, Ferrous-Alloy Butterfly Valve MSS-SP67: two-piece stainless steel stem, coated ductile iron disc, with EPDM seal. Example: Victaulic V-300 Series.

2.5 BRONZE CHECK VALVES

A. Manufacturers:

1. Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:
   a. Cincinnati Valve Company
   b. Crane Company; Crane Valve Group.
   c. NIBCO Incorporated.
   d. Walworth Company
2. Bronze, Vertical Lift Check Valves with Nonmetallic Disc:
   a. Grinnell Corporation.
   b. Kitz Corporation of America.

c. Milwaukee Valve Company.
d. NIBCO Incorporated.

3. Bronze, Swing Check Valves with Metal Disc:
   a. American Valve, Incorporated
   b. Cincinnati Valve Company
   c. Crane Company; Crane Valve Group.
   d. Grinnell Corporation.
   e. Hammond Valve.
   f. Kitz Corporation of America.
   g. Legend Valve & Fitting, Incorporated
   h. Milwaukee Valve Company.
   i. NIBCO Incorporated.
   j. Powell, Wm. Company
   k. Red-White Valve Corporation
   l. Walworth Company
   m. Watts Industries, Incorporated; Water Products Division

B. Bronze Check Valves, General: MSS SP-80.

C. Type 2, Class 125, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat. Example: NIBCO #T-480 or #S-480.

D. Type 2, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat. Example: NIBCO #T-480 or #S-480.

E. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with bronze disc and seat. Example: NIBCO #T-413 or #S-413.

F. Type 3, Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat. NIBCO #T-433 or #S-433.

2.6 GRAY-IRON SWING CHECK VALVES

A. Manufacturers:

1. Gray-Iron Swing Check Valves with Metal Seats:
   a. Cincinnati Valve Company
   b. Crane Company; Crane Valve Group.
   c. Flomatic Valves.
   d. Grinnell Corporation.
   e. Hammond Valve.
   f. Kitz Corporation of America.
   g. Legend Valve & Fitting, Incorporated
   h. Milwaukee Valve Company.
   i. Mueller Company
   j. NIBCO Incorporated
   k. Powell, Wm. Company
   l. Red-White Valve Corporation
   m. Walworth Company
   n. Watts Industries, Incorporated; Water Products Division
2. Gray-Iron Swing Check Valves with Composition to Metal Seats:
   a. Crane Company; Crane Valve Group.
   b. Mueller Company
   c. Watts Industries, Incorporated; Water Products Division
3. Grooved-End, Ductile-Iron Swing Check Valves:
   a. Grinnell Corporation.
   b. Mueller Company
   c. Victaulic Company of America.

B. Gray-Iron Swing Check Valves, General: MSS SP-71.

C. Class 125, gray-iron, swing check valves with metal seats. Example: NIBCO #F-918-B or #T-918-B.

D. 300-psig CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends. Example Victaulic V-716 Series.

2.7 CAST-IRON GLOBE VALVES

A. Manufacturers:
   1. Type I, Cast-Iron Globe Valves with Metal Seats:
      a. Cincinnati Valve Company
      b. Crane Company; Crane Valve Group.
      c. Grinnell Corporation.
      d. Hammond Valve.
      e. Kitz Corporation of America.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Powell, Wm. Company
      i. Red-White Valve Corporation
      j. Walworth Company

B. Cast-Iron Globe Valves, General: MSS SP-85.

C. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with bronze seats. Example: NIBCO #F-718-B.

D. Type I, Class 250, Cast-Iron Globe Valves: Gray-iron body with bronze seats. Example: NIBCO #F-768-B.

2.8 CHAINWHEEL ACTUATORS

A. Manufacturers:
   1. Babbitt Steam Specialty Company.
   2. Roto Hammer Industries, Incorporated.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve
   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   3. Chain: Hot-dip, galvanized steel of size required to fit sprocket rim.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service:
   a. NPS 3 and smaller: Ball valves.
   b. NPS 4 and larger: Butterfly valves.
2. Throttling Service:
   a. NPS 3 and smaller: Ball valves.
   b. NPS 4 and Larger: Butterfly or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves.

B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

C. Domestic Water Piping: Use the following types of valves:
1. Ball Valves, NPS 3 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
2. Butterfly Valves, NPS 4 and Larger: Flanged, 300-psig CWP rating, ferrous alloy, with EPDM liner.
3. Grooved-End, Ductile-Iron Butterfly Valves, NPS 4 and Larger: 300-psig CWP rating.
4. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 150, horizontal or vertical, bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
6. Grooved-End, Ductile-Iron, Swing Check Valves, NPS 2-1/2 and Larger: 300-psig CWP rating.
7. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type I or II, Class 125, cast iron.
8. Globe Valves, 4 and Larger: Type I, Class 125, bronze-mounted cast iron.

D. Sanitary Waste and Storm Drainage Piping: Use the following types of valves:
1. Ball Valves, NPS 3 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
2. Swing Check Valves, NPS 3 and Smaller: Type 3, Class 125, bronze.
3. Swing Check Valves, NPS 4 and Larger: Type I, Class 125, gray iron.

E. Select valves, except wafer and flangeless types, with the following end connections:
1. For Copper Tubing, NPS 3 and Smaller: Threaded ends.
2. For Steel Piping, NPS 4: Flanged or threaded ends.
3. For Steel Piping, NPS 5 and Larger: Flanged ends.
4. For Grooved-End, Steel Piping, NPS 4 and larger: Valve ends may be grooved.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.

2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:
   1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
   2. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass polyurethane or stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:
   1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
   2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.
      c. Flex-Strut Inc.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut Corporation; Tyco International, Ltd.

g. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
7. Metallic Coating: Hot-dipped galvanized.

B. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.6 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
   1. Properties: Non-staining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

L. 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.

M. Install lateral bracing with pipe hangers and supports to prevent swaying.

N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

P. 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.

Q. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

3.2 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.

3.3 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.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 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.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless-steel pipe hangers and and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
3. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
4. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
5. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

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

1.2 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for equipment.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe, complying with ASME A13.1, on each piping system.
   1. Identification Paint: Use for contrasting background.
   2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:
   1. Low-Pressure, Compressed-Air Piping:
      a. Background Color: Blue.
      b. Letter Color: White.
   2. Medium-Pressure, Compressed-Air Piping:
      a. Background Color: Blue.
      b. Letter Color: White.
   3. Domestic Water Piping:
      a. Background Color: Green.
      b. Letter Color: White.
   4. Sanitary Waste and Storm Drainage Piping:
      a. Background Color: Green.
      b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Cold Water: 1-1/2 inches round.
      b. Hot Water: 1-1/2 inches round.
      c. Low-Pressure Compressed Air: 1-1/2 inches round.
      d. High-Pressure Compressed Air: 1-1/2 inches round.
   2. Valve-Tag Color:
      a. Cold Water: Natural.
      b. Hot Water: Natural.
   3. Letter Color:
      a. Cold Water: White.
      b. Hot Water: White.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.
   4. Roof drains and rainwater leaders.
   5. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:
   1. Section 220716 "Plumbing Equipment Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.

d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

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

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field-fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Engineered Brass Company.
   b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
   c. McGuire Manufacturing.
   d. Plumberex.
   e. Truebro; a brand of IPS Corporation.
   f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Truebro; a brand of IPS Corporation.

b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For

valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
1. NPS 2 and Smaller: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.
2. NPS 2-1/2 and Larger: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
1. NPS 1-1/4 and Smaller: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

C. Storm-water and Overflow:
1. Insulate down comers from roof drain bodies, horizontal piping to the connection at main vertical piping, and 5 feet down the vertical piping from the connection. Insulate down comers from overflow roof drain bodies and piping within 5 feet of the overflow roof drains.
2. Insulate all exposed overflow storm water piping.

3. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

E. Condensate and Equipment Drain Water below 60 Degrees F:
   1. Extend insulation to the connection to main sanitary or storm water piping, and all piping within 10 feet of the drain (including sanitary or storm water main piping).
   2. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Degrees F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
   1. Piping located within 8 feet of the floor; less than 200 degrees F: PVC: 30 mils thick.

END OF SECTION

SECTION 221116
DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
   2. Encasement for piping.

1.2 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality control reports.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

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

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: **ASTM B 88, Type L** water tube, drawn temper.

B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

D. Copper Pressure-Seal-Joint Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkhart Products Corporation.
      b. NIBCO Inc.
      c. Viega.
   2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
   3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

E. Copper Push-on-Joint Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Victaulic Company.
   2. Description:
      a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
      b. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.
   3. Mechanical Couplings for Grooved-End Copper Tubing:
      a. Copper-tube dimensions and design similar to AWWA C606.
      b. Ferrous housing sections.

c. EPDM-rubber gaskets suitable for hot and cold water.
d. Bolts and nuts.
e. Minimum Pressure Rating: 300 psig.

2.3 STAINLESS-STEEL PIPING

A. Potable-water piping and components shall comply with NSF 61.

B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 10.

C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.

D. Appurtenances for Grooved-End, Stainless-Steel Pipe:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International.
b. Grinnell Mechanical Products; Tyco Fire Products LP.
c. Shurjoint Piping Products.
d. Victaulic Company.
2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:
a. AWWA C606 for stainless-steel-pipe dimensions.
b. Stainless-steel housing sections.
c. Stainless-steel bolts and nuts.
d. EPDM-rubber gaskets suitable for hot and cold water.
e. Minimum Pressure Rating:
1) NPS 8 and Smaller: 600 psig.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

2.5 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

2.6 TRANSITION FITTINGS

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.; Piping Specialties Products.
   c. Ford Meter Box Company, Inc. (The).
   d. JCM Industries.
   e. Romac Industries, Inc.
   f. Smith-Blair, Inc.; a Sensus company.
   g. Viking Johnson.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
      b. Central Plastics Company.
      c. Matco-Norca.
      d. Watts; a division of Watts Water Technologies, Inc.
      e. Wilkins; a Zurn company.
   2. Standard: ASSE 1079.
   3. Factory-fabricated, bolted, companion-flange assembly.
   4. Pressure Rating: 125 psig minimum at 180 deg F.
   5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric Nipples:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elster Perfection Corporation.
      b. Grinnell Mechanical Products; Tyco Fire Products LP.
      c. Matco-Norca.
      d. Precision Plumbing Products, Inc.
      e. Victaulic Company.
   2. Standard: IAPMO PS 66.
   3. Electroplated steel nipple complying with ASTM F 1545.
   4. Pressure Rating and Temperature: 300 psig at 225 deg F.
   5. End Connections: Male threaded or grooved.
   6. Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping," and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

C. Install shutoff valve immediately upstream of each dielectric fitting.

D. Install domestic water piping level and plumb.

E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

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

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. 2 and Smaller: Plastic-to-metal transition fittings.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 3 and Smaller: Use dielectric couplings or nipples.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
2. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
3. NPS 6: 12 feet with 3/4-inch rod.
4. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

G. Install supports for vertical stainless-steel piping every 15 feet.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.

2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
      c. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
      d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   2. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
      b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
      c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
      d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
      e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
      f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
      b. Adjust calibrated balancing valves to flows indicated.

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

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints NPS 4 and larger, unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping, NPS 3 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; cast-or wrought-copper solder-joint fittings; and soldered joints.
   2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
   3. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

E. Aboveground domestic water piping, NPS 4 and larger, shall be the following:
   1. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball valves for piping NPS 3 and smaller. Use butterfly, with flanged ends for piping NPS 4 and larger.
   2. Throttling Duty: Use ball valves for piping NPS 3 and smaller. Use butterfly valves with flanged ends for piping NPS 4 and larger.
   3. Hot-Water Circulation Piping, Balancing Duty: Calibrated, Memory-stop balancing valves.
   4. Drain Duty: Hose-end ball valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

SECTION 221119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose stations.
9. Hose bibbs.
10. Wall hydrants.
11. Ground hydrants.
12. Post hydrants.
13. Drain valves.
14. Water-hammer arresters.
15. Air vents.
16. Trap-seal primer valves.
17. Trap-seal primer systems.
18. Specialty valves.
19. Flexible connectors.
20. Water meters.

B. Related Requirements:

1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Section 224300 "Medical Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
6. Section 224713 "Drinking Fountains" for water filters for water coolers.
7. Section 224716 "Pressure Water Coolers" for water filters for water coolers.
8. Section 224723 "Remote Water Coolers" for water filters for water coolers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
      b. Cash Acme; a division of Reliance Worldwide Corporation.
      c. Conbraco Industries, Inc.
      d. FEBCO; a division of Watts Water Technologies, Inc.
      e. Rain Bird Corporation.
      f. Toro Company (The); Irrigation Div.
      g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Standard: ASSE 1001.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arrowhead Brass Products.
      b. Cash Acme; a division of Reliance Worldwide Corporation.
      c. Conbraco Industries, Inc.
      d. Legend Valve.
      e. MIFAB, Inc.
      f. Prier Products, Inc.
      g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
      i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
      j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Standard: ASSE 1011.
   3. Body: Bronze, non-removable, with manual drain.
   4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
   5. Finish: Rough bronze.

C. Pressure Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
      b. Conbraco Industries, Inc.
      c. FEBCO; a division of Watts Water Technologies, Inc.
      d. Flomatic Corporation.
      e. Toro Company (The); Irrigation Div.
      f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Standard: ASSE 1020.
   3. Operation: Continuous-pressure applications.

4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: NPS 2”
6. Accessories:
    a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Cash Acme; a division of Reliance Worldwide Corporation.
    b. Conbraco Industries, Inc.
    c. FEBCO; a division of Watts Water Technologies, Inc.
    d. Honeywell International Inc.
    e. Legend Valve.
    f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: NPS 3/4.
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Rough bronze.

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Armstrong International, Inc.
    b. Flo Fab Inc.
    c. ITT Corporation; Bell & Gossett Div.
    d. NIBCO Inc.
    e. TAC.
    f. TACO Incorporated.
    g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: Ball valve with two readout ports and memory-setting indicator.
3. Body: bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Armstrong International, Inc.
    b. Flo Fab Inc.
    c. ITT Corporation; Bell & Gossett Div.
    d. NIBCO Inc.
    e. TAC.
    f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

D. Memory-Stop Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Conbraco Industries, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.

d. Crane Co.; Crane Valve Group; Stockham Div.
e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO Inc.
h. Red-White Valve Corp.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Cash Acme; a division of Reliance Worldwide Corporation.
   c. Conbraco Industries, Inc.
   d. Honeywell International Inc.
   e. Legend Valve.
   f. Leonard Valve Company.
   g. Powers; a division of Watts Water Technologies, Inc.
   h. Symmons Industries, Inc.
   i. TACO Incorporated.
   j. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   k. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: See schedule.
9. Tempered-Water Design Flow Rate: See schedule.
10. Valve Finish: See schedule.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company.
   d. Powers; a division of Watts Water Technologies, Inc.
   e. Symmons Industries, Inc.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: See schedule.
9. Tempered-Water Design Flow Rate: See schedule.
10. Selected Valve Flow Rate at 45-psig Pressure Drop: See schedule.

11. Pressure Drop at Design Flow Rate: See schedule.
12. Valve Finish: Rough bronze.
13. Piping Finish: Copper.

C. Manifold, Thermostatic, Water Mixing-Valve Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Leonard Valve Company.
   b. Powers; a division of Watts Water Technologies, Inc.
   c. Symmons Industries, Inc.
2. Description: Factory-fabricated, exposed-mounted, thermostatically controlled, water mixing-valve assembly in three-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
4. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
5. Small-Flow Parallel: Thermostatic, water mixing valve.
6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
8. Pressure Rating: 125 psig minimum unless otherwise indicated.

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron [with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and] for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.020 inch.

2.8 HOSE BIBBS

A. Hose Bibbs:
1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: See schedule.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: See schedule.
13. Operation for Finished Rooms: See schedule.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.

5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Precision Plumbing Products, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products.
   i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.11 FLEXIBLE CONNECTORS

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

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld Incorporated.
5. Hyspan Precision Products, Inc.
6. Mercer Gasket & Shim, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation.
10. Unaflex.Universal Metal Hose; a Hyspan company.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.
   2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
   3. Do not install bypass piping around backflow preventers.

B. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

E. Install Y-pattern strainers for water on supply side of each balancing valve.

F. Install water-hammer arresters in water piping according to PDI-WH 201.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Pressure vacuum breakers.
   2. Intermediate atmospheric-vent backflow preventers.
   3. Reduced-pressure-principle backflow preventers.
   4. Double-check, backflow-prevention assemblies.
   5. Carbonated-beverage-machine backflow preventers.
   6. Dual-check-valve backflow preventers.
   7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
   8. Double-check, detector-assembly backflow preventers.
   9. Water pressure-reducing valves.
   10. Calibrated balancing valves.
   11. Primary, thermostatic, water mixing valves.
   12. Manifold, thermostatic, water mixing-valve assemblies.
   13. Hose stations.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.
   3. Encasement for underground metal piping.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than five days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without owner’s written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 PIPING MATERIALS

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

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

1. Manufacturers:
   a. AB&I Foundry
   b. Charlotte Pipe and Foundry
   c. Tyler Pipe; Soil Pipe Division

B. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AB&I Foundry
   b. Charlotte Pipe and Foundry
   c. Tyler Pipe; Soil Pipe Division

B. Standard Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Dallas Specialty & Manufacturing Company
   c. Fernco Incorporated
   d. Matco-Norca, Incorporated
   e. MIFAB, Incorporated
   f. Mission Rubber Company; a division of MCP Industries, Incorporated
   g. Stant.
   h. Tyler Pipe.
2. Standards: ASTM C 1277; CISPI Designation 310-09, NSF Certified.
3. Description: 301 stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, Neoprene sleeve with integral, center pipe stop.
4. Bands:
   a. NPS 4 inches and less: 2 bands, 60 inch pounds torque.
   b. NPS 5 to NPS 10: 4 bands, 60 inch pounds torque.
   c. NPS 12 and larger: 6 bands, 80 inch pounds torque.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Solvent Cement: ASTM D 2564.

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Non-pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Dallas Specialty & Manufacturing Company
         2) Fernco Incorporated
         3) Mission Rubber Company; a division of MCP Industries, Incorporated
         4) Plastic Oddities; a division of Diverse Corporate Technologies, Incorporated
      b. Standard: ASTM C 1173, NSF Certified.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. Sleeve Materials:
         1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
         2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
         3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   4. Shielded, Non-pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
         1) Cascade Waterworks Manufacturing Company
         2) Mission Rubber Company; a division of MCP Industries, Incorporated
      b. Standard: ASTM C 1460, NSF Certified.
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch.

C. Form: Sheet.

D. Color: Black.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Sanitary sewer piping more than 5-feet outside the building is specified in Division 33 Section "Sanitary Sewerage."

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

M. Install underground PVC piping according to ASTM D 2321.

3.3 PLUMBING SPECIALTIES

A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."

B. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

C. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

D. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

E. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

F. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.5 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, non-pressure transition couplings.
   3. In Aboveground Force Main Piping: Fitting-type transition couplings.
   4. In Underground Force Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2 and Larger: Pressure transition couplings.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install fiberglass pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 18 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
   6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

H. Bracing: Horizontal cast-iron pipe and fittings NPS 5 and larger shall be braced to prevent horizontal movement. Bracing shall be located at each branch connection and each change of direction.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

A. Aboveground, soil and waste piping NPS 1.5 and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; standard hubless-piping couplings; and coupled joints.

B. Aboveground, soil and waste piping NPS 2 to NPS 10 shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; standard hubless-piping couplings; and coupled joints.

C. Aboveground, vent piping NPS 1.5 and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; standard hubless-piping couplings; and coupled joints.

D. Aboveground, vent piping NPS 2 to NPS 10 shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; standard hubless-piping couplings; and coupled joints.

E. Underground, soil, waste, and vent piping NPS 12 and smaller shall be the following:
   1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

F. Underground, soil and waste piping NPS 15 and larger shall be the following:
   1. Cellular-core PVC pipe; PVC socket fittings; and solvent-cemented joints.
   2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION

SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cleanouts.
   2. Floor drains.
   3. Roof flashing assemblies.
   4. Through-penetration fire stops assemblies.
   5. Miscellaneous sanitary drainage piping specialties.
   6. Flashing materials.
   7. Oil interceptors.

B. Related Requirements:
   1. Division 22 Section "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.
   2. Division 22 Section "Plumbing Fixtures" for hair interceptors.
   3. Division 22 Section "Healthcare Plumbing Fixtures" for plaster sink interceptors.
   4. Division 33 Section "Storm Utility Drainage Piping" for storm draining piping and piping specialties outside the building.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.3 PRODUCT ACTION SUBMITTALS

A. Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
   1. Oil interceptors.
   2. Floor Drains

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
   1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

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 NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cultures: Provide 1-gallon bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gallon bottles.

PART 2 PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
   g. Josam Company; Blucher-Josam Div.
2. Standard: ASME A112.36.2M for cast iron or ASME A112.3.1 for stainless steel for cleanout test tee.
3. Refer to cleanout schedule on drawings.

B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.
   i. Kusel Equipment Co.
2. Standard: ASME A112.36.2M
3. Refer to cleanout schedule on drawings.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
4. Refer to cleanout schedule on drawings.

D. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Plastic Oddities; a division of Diverse Corporate Technologies.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
2. Size: Same as connected branch.
3. Body: PVC.
4. Refer to cleanout schedule on drawings.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3 with backwater valve.
3. Refer to floor drain schedule on drawings:

B. Stainless Steel Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Blucher-Josam Div.
   b. Josam Company; Josam Div.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.3.1 or ASME A112.6.3.
3. Refer to floor drain schedule on drawings:

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Engineering Company; Elmdor/Stoneman Div.
   b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counter flashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Fire stop Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ProSet Systems Inc.
   2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
   3. Size: Same as connected soil, waste, or vent stack.
   4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
   6. Special Coating: Corrosion resistant on interior of fittings.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:
   1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
   2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch- minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Stack Flashing Fittings:
   1. Description: Counter-flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:
   1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
   2. Size: Same as connected stack vent or vent stack.

G. Frost-Resistant Vent Terminals:
   1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper or galvanized steel.
   2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter-flashing.

H. Expansion Joints:
   1. Standard: ASME A112.21.2M.

2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
   2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
   3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz. /sq. ft.
   2. Vent Pipe Flashing: 8 oz. /sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. Install through-penetration fire stop assemblies in plastic conductors and stacks at floor penetrations.

H. Install deep-seal traps on floor drains and other waste outlets, if indicated.

I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

L. Install vent caps on each vent pipe passing through roof.

M. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

N. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

O. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

P. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 23 Section "Facility Fuel-Oil Piping."

Q. Install wood-blocking reinforcement for wall-mounting-type specialties.

R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Oil Interceptors: Connect inlet, outlet, vent, and gravity draw off piping to unit; flow-control fitting and vent to unit inlet piping; and gravity draw off and suction piping to oil storage tank.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counter-flashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Oil interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and grease removal devices and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain oil interceptor system. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 221323
SANITARY WASTE INTERCEPTORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Oil interceptors.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PP: Polypropylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of metal interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
   1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from Installers of the items involved:
   1. Interceptors.
   2. Piping connections. Include size, location, and elevation of each.
   3. Interface with underground structures and utility services.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of service.
   2. Do not proceed with interruption of sewer services without Owner's written permission.

PART 2 PRODUCTS

2.1 OIL INTERCEPTORS

A. Oil Interceptors: Factory-fabricated, steel body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Schier Products Company.
      b. Smith, Jay R. Mfg. Co.
      c. Watts Water Technologies, Inc.
      d. Zurn Plumbing Products Group; Zurn Specification Drainage Products.
   2. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
   3. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
   4. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, vehicular traffic load.

5. Comply with requirements in Section 231113 "Facility Fuel-Oil Piping" for waste-oil storage tank and piping

B. Capacities and Characteristics:
   1. Refer to equipment schedule for capacity and characteristics.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION

A. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.

B. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

C. Set tops of manhole frames and covers flush with finished surface in pavements.

D. Set tops of grating frames and grates flush with finished surface.

E. Set **metal** interceptors level and plumb.

F. Set tops of metal interceptor covers flush with finished surface in pavements.

G. Install piping and oil storage tanks according to Section 231113 "Facility Fuel-Oil Piping."

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

A. Identification materials and installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
   1. Use warning tapes or detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION

SECTION 221413
FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.
   3. Encasement for underground metal piping.

1.2 DEFINITIONS

A. Hub Drain: Open ended drainage pipe. The hub end of a hub and spigot cast iron, or PVC pipe; open pipe end of a cast iron no-hub system. Hub drain material shall be the same as the connecting drainage system.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, and details.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of storm-drainage service.
   2. Do not proceed with interruption of storm-drainage service without Owner's written permission.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AB&I Foundry
   b. Charlotte Pipe and Foundry
   c. Tyler Pipe; Soil Pipe Division

B. CISPI, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Dallas Specialty & Mfg. Co.
   c. Fernco Inc.
   d. Matco-Norca, Inc.
   e. MIFAB, Inc.
   f. Mission Rubber Company; a division of MCP Industries, Inc.
   g. Stant.
2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Clamp-All Corp.
   c. Dallas Specialty & Mfg. Co.
   d. MIFAB, Inc.
   e. Mission Rubber Company; a division of MCP Industries, Inc.
   f. Stant.
   g. Tyler Pipe.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.
1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Solvent Cement: ASTM D 2564.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Non-pressure Transition Couplings:
4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1) Dallas Specialty & Mfg. Co.
    2) Fernco Inc.
    3) Mission Rubber Company; a division of MCP Industries, Inc.
    4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
    b. Standard: ASTM C 1173.
    c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. Sleeve Materials:
        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
5. Shielded, Non-pressure Transition Couplings:
6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1) Cascade Waterworks Mfg. Co.
    2) Mission Rubber Company; a division of MCP Industries, Inc.
    b. Standard: ASTM C 1460.
    c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
7. Pressure Transition Couplings:
8. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1) Cascade Waterworks Mfg. Co.
    2) Dresser, Inc.
    3) EBAA Iron, Inc.
    4) Ford Meter Box Company, Inc. (The)
    5) JCM Industries, Inc.
    6) Romac Industries, Inc.
    7) Smith-Blair, Inc.; a Sensus company.
    8) Viking Johnson; c/o Mueller Co.
    b. Standard: AWWA C219.
    c. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.
    d. Center-Sleeve Material: Manufacturer's standard
    e. Gasket Material: Natural or synthetic rubber.
    f. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
   1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install steel piping according to applicable plumbing code.

O. Install underground PVC piping according to ASTM D 2321.

P. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

Q. Plumbing Specialties:
   1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."
   2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
   3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Plastic, Non-pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, non-pressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:
   a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
   b. NPS 2 and Larger: Pressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install fiberglass pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 Feet: MSS Type 1, adjustable, steel clevis hangers.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 18 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.
   1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
   2. Install horizontal backwater valves [with cleanout cover flush with floor] [in pit with pit cover flush with floor] <Insert description>.
   3. Comply with requirements for cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."

D. Connect force-main piping to the following:
   1. Storm Sewer: To exterior force main.
   2. Sump Pumps: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.

D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   3. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
   4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION

SECTION 221423
STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Cleanouts.
   4. Backwater valves.
   5. Trench drains.
   6. Channel drainage systems.
   7. Through-penetration firestop assemblies.
   8. Flashing materials.

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.1 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:
   1. Standard: ASME A112.21.2M.
   2. Body: Cast iron with bronze sleeve, packing, and gland.
   3. End Connections: Matching connected piping.
   4. Size: Same as connected piping.

2.2 CLEANOUTS

A. Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. Josam Company.
      b. Oatey.
      c. Sioux Chief Manufacturing Company, Inc.
      d. Smith, Jay R. Mfg. Co.
      e. Tyler Pipe.
      f. Watts Water Technologies, Inc.
      g. Zurn Plumbing Products Group; Light Commercial Products Operation.
      h. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M, for cleanouts.
   3. Size: Same as connected branch.
   4. Type: Adjustable housing.
   5. Body or Ferrule Material: Cast iron.
   6. Clamping Device: Not required.
   7. Adjustable Housing Material: Cast iron with threads.
   8. Frame and Cover Shape: Round.
   9. Top-Loading Classification: Medium Duty.
   10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
   a. .

2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. ProSet Systems Inc.
   2. Standard: ASTM E 814, for through-penetration firestop assemblies.
   3. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
   4. Size: Same as connected pipe.
   5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
   7. Special Coating: Corrosion resistant on interior of fittings.

2.4 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz. /sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

B. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate cleanouts at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

F. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

G. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221513
GENERAL-SERVICE COMPRESSED-AIR PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig or less.

B. Hose Reels

C. Accessories

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. CR: Chlorosulfonated polyethylene synthetic rubber.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. HDPE: High-density polyethylene plastic.

E. NBR: Acrylonitrile-butadiene rubber.

F. PE: Polyethylene plastic.

G. PVC: Polyvinyl chloride plastic.

H. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.

I. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Plastic pipes, fittings, and valves.
2. Dielectric fittings.
3. Flexible pipe connectors.
4. Safety valves.
5. Pressure regulators: Include rated capacities and operating characteristics.
6. Automatic drain valves.
7. Filters: Include rated capacities and operating characteristics.
8. Lubricators: Include rated capacities and operating characteristics.
9. Quick couplings.
10. Hose assemblies.

B. Brazing and welding certificates.

C. Qualification Data: For Installers.

D. Field quality control test reports.

E. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

3. Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by Victaulic Company.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

D. ASME Compliance:
   1. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.
   2. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of compressed-air service.
   2. Do not proceed with interruption of compressed-air service without Owner's written permission.

PART 2 PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.
   1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
   2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
   3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
   4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
   5. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.
   6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
   7. Grooved-End Fittings and Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Anvil International, Inc.
         2) Victaulic Company.
         3) Ward Manufacturing, Inc.
      b. Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron casting; with grooves according to AWWA C606 and dimensions matching steel pipe.
      c. Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for 300-psig minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.

B. Schedule 5, Steel Pipe: ASTM A 135, carbon steel with plain ends and zinc-plated finish.
   1. Pressure-Seal Fittings: Listed and labeled by a qualified testing agency and FMG-approved, carbon-steel, pressure-seal housing with O-ring end seals suitable for compressed-air piping and rated for 300-psig minimum working pressure. Provide EDPM seals for oil-free compressed air. Provide NBR seals if compressed air contains oil or oil vapor.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Victaulic Company.

C. Copper Tube: ASTM B 88, Type L seamless, drawn-temper, water tube.
   1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.

2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
3. Copper Unions: ASME B16.22 or MSS SP-123.
4. Press-Type Fittings, NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Viega; Plumbing and Heating Systems.
5. Press-Type Fittings, NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Viega; Plumbing and Heating Systems.
6. Extruded-Tee Outlets: Procedure for making branch outlets in copper tube according to ASTM F 2014.
    a. Manufacturers: Subject to compliance with requirements, provide procedure according to one of the following:
        1) T-DRILL Industries Inc.
7. Grooved-End Fittings and Couplings:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Anvil International, Inc.
        2) Victaulic Company.
    b. Grooved-End Fittings: ASTM B 75, copper tube or ASTM B 584, bronze castings.
    c. Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gasket for oil-free compressed air. Provide NBR gasket if compressed air contains oil or oil vapor.

D. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

E. PVC Pipe: ASTM D 1785, Schedule 40.
    1. PVC Fittings: ASTM D 2466, Schedule 40, socket type.

F. Blue ABS Piping System: Made of ASTM D 3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are light blue and sizes are in millimeters.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. IPEX Inc.
    2. Transition Fittings, 20 to 63 mm: Composite union with ABS socket end, CR O-ring, and malleable-iron union nut and threaded end; with construction similar to MSS SP-107, transition union.
    3. Transition Fittings, 90 to 110 mm: Flange assembly with ABS flange, CR gasket, and metal flange of material matching piping to be connected.
    4. Valves, 20 to 63 mm: ABS union ball valve with socket ends.
    5. Valves, 90 to 110 mm: ABS butterfly valve with lever handle.

G. Green ABS Piping System: Made of ASTM D 3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark green with SDR of 9.0 and same OD as ASTM A 53/A 53M, steel pipe.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. NIBCO INC.
    2. Transition Fittings, NPS 1/2 to NPS 2: Composite union with ABS socket end, CR O-ring, ABS union nut, and brass solder-joint end; with construction similar to MSS SP-107, transition union.
    3. Transition Fittings, NPS 2-1/2 to NPS 4: ABS flange, CR gasket, and metal flange of material matching piping to be connected.
    4. Valves, NPS 1/2 to NPS 2: Union ball valve with socket ends.
    5. Valves, NPS 2-1/2 to NPS 4: Union ball valve with flanged ends. Include safety exhaust feature in Part 3 "Valve Applications" Article if required.

H. HDPE Piping System: Made of ASTM D 1248, HDPE resin to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark blue with pipe dimensions about the same OD as ASTM D 3035, PE pipe.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Asahi/America.
   2. Transition Fittings, NPS 1/2 to NPS 2: HDPE adapter with one socket end and one end with threaded brass insert.
   3. Transition Fittings, NPS 2-1/2 to NPS 4: HDPE flange, CR gasket, and metal flange of material matching piping to be connected.
   4. Valves, NPS 1/2 to NPS 3: HDPE union ball valve with socket ends.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

2.3 VALVES

A. Metal Ball, Butterfly, Check, Gate, and Globe Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping."

2.4 DIELECTRIC FITTINGS

A. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Dielectric Unions: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. EPCO Sales, Inc.
      d. Hart Industries International, Inc.
      e. Watts Water Technologies, Inc.; Water Products Div.
      f. Zurn Plumbing Products Group; Wilkins Div.

C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. EPCO Sales, Inc.
   d. Watts Water Technologies, Inc.; Water Products Div.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.

2.5 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Hyspan Precision Products, Inc.
   4. Mercer Rubber Co.
   5. Metraflex, Inc.
   6. Proco Products, Inc.
   7. Unaflex, Inc.
   8. Universal Metal Hose; a Hyspan Company

B. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: 250 psig minimum.
   2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections, NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: 250 psig minimum.
   2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
   3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

A. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   1. Finish: [Polished chrome-plated] [Rough brass] [Polished chrome-plated and rough brass].

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.8 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.
   1. Type: Pilot operated.

C. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.

D. Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.

E. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated.

F. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.

G. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal. Include mounting bracket if wall mounting is indicated.
   1. Provide with automatic feed device for supplying oil to lubricator.

2.9 QUICK COUPLINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aeroquip Corporation; Eaton Corp.
   2. Bowes Manufacturing Inc.
   3. Foster Manufacturing, Inc.
   4. Milton Industries, Inc.
   5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
   6. Rectus Corp.
   7. Schrader-Bridgeport; Amflo Div.
   8. Schrader-Bridgeport/Standard Thomson.
   9. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
   10. TOMCO Products Inc.
   11. Tuthill Corporation; Hansen Coupling Div.

B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless steel or nickel-plated-steel operating parts.

1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
2. Plug End: Flow-sensor-bleeder, check-valve type with barbed outlet for attaching hose.

D. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
2. Plug End: With barbed outlet for attaching hose.

2.10 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.

1. Hose: Reinforced single- or double wire-braid, CR-covered hose for compressed-air service.
2. Hose Clamps: Stainless-steel clamps or bands.
3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

2.11 HOSE REELS - AIR

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

1. GRACO HSL-C8B XD SERIES SIZE 30 OPEN STYLE WATER REEL.OR EQUAL.
2. Manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to hose reel schedules

C. Description:

1. HEAVY DUTY, LARGE CAPACITY SPRING POWERED. REEL TO HAVE 1/4" STEEL BASE, 7 GAUGE STEEL PEDESTAL SUPPORT, AND 7 GAUGE DOUBLE REEL SUPPORT GUSSET, WITH 16 GAUGE STEEL REEL FLANGE.
2. REEL TO HAVE MACHINED SHAFT WITH MINIMUM PORTING OF 1/2" AND TO INCLUDE OIL-LITE BEARING AND CAST STEEL RACHET ASSEMBLY.
3. REEL TO HAVE FOUR (4) REPLACEABLE ALL WEATHER ROLLER GUIDES MOUNTED ON A 270 DEGREE ADJUSTABLE ARTICULATING HOSE GUIDE HEAD.
4. SUPPORT ARMS FOR REEL TO BE ADJUSTABLE FOR WALL, FLOOR OR OVERHEAD MOUNTING AND REEL TO HAVE A THREE (3) YR COMPLETE WARR.
5. TO INCLUDE 75' x 1/2" HOSE WITH BALL STOP. BLUE PAINT.

D. Accessories:

1. Provide a ½" air shut off valve
   a. GRACO 107-142 OR EQUAL.
2. Provide a 2' x ¾" inlet hose kit
   a. GRACO 24E-284 OR EQUAL.

2.12 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials for each size range:

1. NPS 2 and Smaller: Type L, copper tube; wrought-copper fittings; and brazed joints.
2. NPS 2-1/2 to NPS 4: Type L, copper tube; wrought-copper fittings; and brazed joints.

B. Drain Piping: Use the following piping materials:

1. NPS 2 and Smaller: PVC pipe and fittings; and solvent-cemented joints.

3.2 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.

1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section "General-Duty Valves for Plumbing Piping" according to the following:
   a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
   b. High-Pressure Compressed Air: Valve types specified for medium-pressure compressed air.
   c. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
   d. Grooved-end valves may be used with grooved-end piping and grooved joints.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Install piping adjacent to equipment and machines to allow service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
2. Use cast-copper-alloy companion flange with gasket and brazed or soldered joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Flanged joints may be used instead of specified joint for any piping or tubing system.

J. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.

K. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

L. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

M. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

N. Install piping to permit valve servicing.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.

E. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."

G. Extruded-Tee Outlets for Copper Tubing: Form branches according to ASTM F 2014, with tools recommended by procedure manufacturer, and using operators qualified according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

I. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join according to AWWA C606 for grooved joints. Do not apply lubricant to prelubricated gaskets.

J. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 for socket-fusion joints.

K. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.

L. Solvent-Cemented Joints for ABS Piping: Clean and dry joining surfaces. Join according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2235 Appendix.

M. Solvent-Cemented Joints for PVC Piping: Clean and dry joining surfaces. Join according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

N. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.

C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.

D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 and Smaller: Use dielectric unions.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment and tools.

D. Install automatic drain valves on after-coolers, receivers, and dryers. Discharge condensate onto nearest floor drain.

E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated.

F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.

G. Install air-line lubricators in branch piping to machine tools. Mount on wall at locations indicated.

H. Install quick couplings at piping terminals for hose connections.

I. Install hose assemblies at hose connections.

3.9 CONNECTIONS

A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

B. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.10 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe or PVC pipe.

D. Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.

1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

E. Install sleeves in new walls and slabs as new walls and slabs are constructed.

F. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. PVC or Steel Pipe Sleeves: For pipes smaller than NPS 6.
2. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum board partitions.
3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
   a. Seal space outside of sleeve fittings with grout.

G. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.11 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

B. New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Existing Piping:

1. Chrome-Plated Piping: Split-casting, cast brass with chrome-plated finish.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting,.
4. Bare Piping in Unfinished Service Spaces: Split casting.
5. Bare Piping in Equipment Rooms: Split casting, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.12 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

I. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
3. NPS 1-1/2: 12 feet with 3/8-inch rod.
4. NPS 2: 13 feet with 3/8-inch rod.
5. NPS 2-1/2: 14 feet with 1/2-inch rod.
6. NPS 3: 15 feet with 1/2-inch rod.
7. NPS 3-1/2: 16 feet with 1/2-inch rod.
8. NPS 4: 17 feet with 5/8-inch rod.
9. NPS 5: 19 feet with 5/8-inch rod.
10. NPS 6: 21 feet with 3/4-inch rod.
11. NPS 8: 24 feet with 3/4-inch rod.
12. NPS 10: 26 feet with 7/8-inch rod.
13. NPS 12: 30 feet with 7/8-inch rod.

J. Install supports for vertical, Schedule 40, steel piping every 15 feet.

K. Install hangers for Schedule 5, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/2: 72 inches with 3/8-inch rod.
2. NPS 3/4: 84 inches with 3/8-inch rod.
3. NPS 1: 96 inches with 3/8-inch rod.
4. NPS 1-1/4: 108 inches with 3/8-inch rod.
5. NPS 1-1/2: 10 feet with 3/8-inch rod.
6. NPS 2: 11 feet with 3/8-inch rod.

L. Install supports for vertical, Schedule 5, steel piping every 10 feet.

M. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

N. Install supports for vertical copper tubing every 10 feet.

O. Install vinyl-coated hangers for ABS piping with the following maximum horizontal spacing and minimum rod diameters:

1. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F.
2. NPS 3/8 and NPS 1/2: 30 inches with 3/8-inch rod.
3. NPS 3/4: 38 inches with 3/8-inch rod.
4. NPS 1: 40 inches with 3/8-inch rod.
5. NPS 1-1/4: 45 inches with 3/8-inch rod.
6. NPS 1-1/2: 52 inches with 3/8-inch rod.
7. NPS 2: 58 inches with 3/8-inch rod.
8. NPS 3: 68 inches with 1/2-inch rod.
9. NPS 4: 76 inches with 1/2-inch rod.

P. Install supports for vertical ABS piping every 48 inches.

Q. Install vinyl-coated hangers for HDPE piping with the following maximum horizontal spacing and minimum rod diameters:

1. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F.
2. NPS 1/2: 30 inches with 3/8-inch rod.
3. NPS 3/4: 35 inches with 3/8-inch rod.
4. NPS 1: 40 inches with 3/8-inch rod.
5. NPS 1-1/4: 43 inches with 3/8-inch rod.
6. NPS 1-1/2: 49 inches with 3/8-inch rod.
7. NPS 2: 55 inches with 3/8-inch rod.
8. NPS 3 and NPS 4: 96 inches with 1/2-inch rod.

R. Install supports for vertical HDPE piping every 48 inches.

3.13 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.14 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Piping Leak Tests for ABS Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 110 deg F or less, to pressure of 40 psig above system operating pressure, but not less than 100 psig or more than 120 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
3. Piping Leak Tests for HDPE Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 100 deg F or less, to pressure of 40 psig above system operating pressure, but not less than 150 psig or more than 180 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
4. Repair leaks and retest until no leaks exist.
5. Inspect filters lubricators and pressure regulators for proper operation.

C. Prepare test reports.

END OF SECTION

SECTION 224000
PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets.
   2. Commercial sinks.

B. Related Sections include the following:
   1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
   2. Division 22 Section "Emergency Plumbing Fixtures."

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Stainless Steel Residential Sinks: ASME A112.19.3.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Faucets: ASME A112.18.1.
2. Hose-Connection Vacuum Breakers: ASSE 1011.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
5. NSF Potable-Water Materials: NSF 61.
6. Pipe Threads: ASME B1.20.1.
7. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
8. Supply Fittings: ASME A112.18.1.
9. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Manual-Operation Flushometers: ASSE 1037.
4. Plastic Tubular Fittings: ASTM F 409.
5. Brass Waste Fittings: ASME A112.18.2.
6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Flexible Water Connectors: ASME A112.18.6.
2. Floor Drains: ASME A112.6.3.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures of unit shell.
   b. Faulty operation of controls, blowers, pumps, heaters, and timers.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period for Commercial Applications: Three years from date of Substantial Completion.
3. Warranty Period Applications of Pumps and Blowers: Five years from date of Substantial Completion.
4. Warranty Period for Applications of Electronic Controls: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SINK FAUCETS

A. Sink Faucets: Refer to plumbing fixture schedule.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Chicago Faucets.
   b. Delta Faucet Company.
   c. Elkay Manufacturing Company
   d. Zurn Plumbing Products Group; Commercial Brass Operation.

2.2 FIXTURE SUPPORTS

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

1. Josam Company.
2. Smith, Jay R. Mfg. Company
3. Tyler Pipe; Wade Division
4. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Sink Supports: Refer to plumbing fixture schedule.

1. Description: Type I, sink carrier with exposed arms and tie rods, type II, sink carrier with hanger plate, bearing studs, and tie rod, and type III, sink carrier with hanger plate and exposed arms for sink-type fixture. Include steel uprights with feet.

2.3 COMMERCIAL SINKS

A. Commercial Sinks: Refer to plumbing fixture schedule.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay Manufacturing Company.
   b. Just Manufacturing Company.

PART 3 EXECUTION

3.1 COORDINATION

A. Coordinate plumbing fixture rough-in locations and plumbing fixture manufactures installation requirements.

3.2 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed before rough-in.

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

3.3 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install counter-mounting fixtures in and attached to casework.

F. Install fixtures level and plumb according to roughing-in drawings.

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

J. Install accessible urinals with rim height not more than 17-inches or less than 16.5-inches above the finished floor.

K. Install flush valves for accessible urinals with handle centered 44-inches above the finished floor.

L. Install toilet seats on water closets.

M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

O. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

Q. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

R. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.6 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

3.7 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.8 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224500
EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Eye/face wash equipment.
   2. Supplemental equipment.
   3. Water-tempering equipment.

1.2 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

D. Tepid: Moderately warm.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

D. Field quality control test reports.

1.4 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

B. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

C. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities "Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 PRODUCTS

2.1 EYE/FACE WASH EQUIPMENT

A. Standard, Wall-Mounted, Plumbed, Eye/Face Wash Units:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
      a. Bradley Corporation.
      b. Haws Corporation.
   2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
   3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   4. Control-Valve Actuator: Paddle.
   5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
   6. Receptor: Chrome-plated brass or stainless-steel <Insert material> bowl.
   7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.

8. Mounting: Wall bracket.

2.2 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following but are not limited to, the following:
   2. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Bradley Corporation.
      b. Leonard Valve Company.
      c. Powers; a division of Watts Water Technologies, Inc.
   3. Description: Factory-fabricated equipment with thermostatic mixing valve.
      a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
      b. Supply Connections: For hot and cold water.

2.3 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball, valves if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Division 22 "General-Duty Valves for Plumbing Piping."

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Division 22 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Division 22 "Meters and Gages for Plumbing Piping."

G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Division 22 "Sanitary Waste and Vent Piping."

H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Division 22 "Sanitary Waste and Vent Piping."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

J. Fill self-contained fixtures with flushing fluid.

3.3 CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Division 22 "Domestic Water Piping."

B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Division 22 "Sanitary Waste and Vent Piping."

C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Division 22 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

D. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

1. Recommends emergency eyewash and shower equipment be tested weekly to flush impurities and ensure proper flow.
2. Flow test emergency eyewash and shower equipment within 7-days of the date of Substantial Completion, or prior to owner occupancy.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION

SECTION 230500
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. HVAC demolition.
   3. Equipment installation requirements common to equipment sections.
   4. Painting and finishing.
   5. Concrete bases.
   6. Supports and anchorages.

1.3 BASIS-OF-DESIGN

A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufactures listed in the specification other than the basis-of design manufacture are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.4 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

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

1.5 SUBMITTALS

A. Welding certificates.

B. Coordination Drawings: Submit one copy for the engineers use. Division 23 coordination drawings will not be returned.
   1. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
      a. Planned piping layout, including valve and specialty locations and valve-stem movement.

b. Planned piping hanger layout including building attachments and building structural coordination.
c. Clearances for installing and maintaining insulation.
d. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
e. Equipment and accessory service connections and support details
f. Exterior wall and foundation penetrations.
g. Fire- and smoke-rated wall and floor penetration.
h. Sizes and locations of required concrete equipment curbs and bases.
i. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
j. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
k. Access door and panel locations.
l. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

C. Equipment startup reports.
1. Reports will indicate equipment was started and tested according to the manufactures recommendations and is operating as specified. Included test data.

1.6 QUALITY ASSURANCE

A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.7 GUIDELINES, CODES AND STANDARDS

A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.

B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Deliver ducts and air handling equipment with factory or shop applied protective covering. Protective covering shall remain until installation.

C. Materials and equipment stored on site shall have a protective covering; open ends on equipment connections and ducts shall be covered. Duct liner shall be encapsulated.

1.9 COORDINATION

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

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

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Flange Bolts and Nuts: ASME B18.2.1, Type 316 Stainless steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 CONCRETE BASES

A. Refer to Division 03 Section "Cast-in-Place Concrete".

PART 3 EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in doors at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Select system components with pressure rating equal to or greater than system operating pressure.

H. Sleeves are not required for core-drilled holes through walls.

I. Verify final equipment locations for roughing-in.

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

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in steel piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install HVAC equipment according to the equipment manufacturer’s installation instructions and as indicated on the drawings. Resolve conflicting instructions, with the architect before mounting equipment.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

F. Refer to equipment shop drawings for rough in locations; do not scale drawings.

3.6 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete”.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

END OF SECTION

SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with current NEMA MG 1 unless otherwise indicated.

C. Comply with current IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

H. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure Material: Cast iron for motor frame sizes [324T] and larger; rolled steel for motor frame sizes smaller than [324T].

J. Shaft: Grounded

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Shaft: Grounded with Aegis grounding rings.

B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.
5. Brushless DC (ECM)

B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

C. Motors 1/20 HP and Smaller: Shaded-pole type.

D. 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.

E. Brushless DC (ECM) motor requirements are specified in Division 23 equipment sections.

PART 3 EXECUTION

END OF SECTION

SECTION 230514
VARIABLE SPEED DRIVES FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 26 Sections for power supply wiring; field installed disconnects, and required electrical devices.

1.3 DEFINITIONS

A. ACS: Automatic Control System.

B. BMS: Building Management System.

C. IGBT: Integrated gate bipolar transistor.

D. LAN: Local area network.

E. PID: Control action, proportional plus integral plus derivative.

F. PWM: Pulse-width modulated.

G. VFD: Variable frequency (speed) drive.

H. VSD: Variable speed drive.

1.4 SUBMITTALS

A. Product Data: For each type of VSD. Include dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VSD.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current ratings of integrated unit.
      d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
      e. Features, characteristics, ratings, and factory settings of each unit.
   2. Wiring Diagrams: Power, signal, and control wiring for VSD. Provide schematic wiring diagram for each type of VSD.

C. Coordination Drawings: Floor plans, drawn to scale showing dimensioned layout, required working clearances, and required area above and around VSD's where pipe and ducts are prohibited. Show VSD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For manufacturer and service agency.

E. Field quality control test reports.

F. Manufacturer and service agency field service report.

G. Startup Report.

H. Operation and Maintenance Data: For VSD's, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for VSD's and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

I. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.5 QUALITY ASSURANCE

A. Manufacturer and Service Agency Qualifications: A qualified manufacturer's representative supported by a service agency capable of providing training, parts, and emergency maintenance and repairs. Service agency shall be maintained within 50 miles of the Project site.

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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VSD's, minimum clearances between VSD's, and adjacent surfaces and other items. Comply with indicated dimensions and clearances.

D. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store VSD's indoors in clean, dry space with uniform temperature to prevent condensation. Protect VSD's from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover VSD's to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise noted.
   1. Ambient Temperature: 0 to 40 deg C.
   2. Humidity: Less than 90 percent (non-condensing).
   3. Altitude: Not exceeding 3300 feet.

1.8 COORDINATION

A. Coordinate layout and installation of VSD's with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of equipment support stands. Equipment supports for electrical devices are specified in Division 26 Sections.

C. Coordinate features, accessories, and functions of each VSD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB Power Distribution, Incorporated; ABB Control, Incorporated Subsidiary.
   2. Cutler-Hammer; Eaton Corporation (www.eatonelectrical.com)
   3. Danfoss Incorporated; Danfoss Electronic Drives Division.

4. Toshiba International Corporation.
5. Yaskawa Electric America Incorporated.

2.2 VARIABLE SPEED DRIVES

A. Description: NEMA ICS 2, IGBT, PWM, VSD; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, energy efficiency induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG-1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

1. Specific electrical requirements for mechanical equipment are scheduled on the Drawings. Motor horsepower are scheduled on the Mechanical Drawings. Electrical characteristics (voltage, phase, frequency) are scheduled on the Electrical Drawings.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of plus or minus 5 percent for 200 to 240 V, and plus or minus 10 percent for 460 to 480 V.
2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque.
7. Speed Regulation: Plus or minus 1 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum RPM.
2. Maximum Speed: 80 to 100 percent of maximum RPM.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Under- and over voltage trips; inverter over temperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 10 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor over temperature fault.

H. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

I. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.

J. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.

K. Input Line Conditioning: Provide input line reactors and/or filters to limit total harmonic voltage distortion to less than 5 percent.

L. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Over voltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.

M. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

N. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
   1. Output frequency (Hz).
   2. Motor speed (RPM).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (VDC).
   9. Set-point frequency (Hz).
   10. Motor output voltage (V).

O. Control Signal Interface: Provide VSD with the following:
   1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 Vdc or 0/4 to 20 mA) and 6 programmable digital inputs.
   2. Auxiliary Contracts: A minimum of 4 pair auxiliary contacts for remote start/stop control from hard-wired limit switches, such as smoke alarm, freeze thermostat, high pressure limit controls.
   3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the ACS or other control systems:
      a. 0 to 10-V dc.
      b. 0 to 20 or 4 to 20 mA.
      c. Potentiometer using up/down digital inputs.
      d. Fixed frequencies using digital inputs.
      e. RS485.
      f. Keypad display for local hand operation.
   4. Output Signal Interface:
      a. A minimum of 1 analog output signal (0/4 to 20 mA), which can be programmed to any of the following:
         1) Output frequency (Hz).
         2) Output current (load).
         3) DC-link voltage (VDC).
         4) Motor torque (percent).
         5) Motor speed (RPM).
         6) Set-point frequency (Hz).
   5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      a. Motor running.
      b. Fault and warning indication (any fault or alarm condition).

P. Communications: Provide an RS485 interface allowing VSD to be used with an external system within a multi drop LAN configuration. Interface shall allow all parameter settings of VSD to be programmed via ACS control. Provide capability for VSD to retain these settings within the nonvolatile memory.

Q. Remote Indicating Circuit Terminals: Controller status and controller fault.

2.3 ENCLOSURES

A. Enclosure: (Interior) NEMA 1, fully enclosed, vertically configured with front accessible controls and components to allow for wall, freestanding, or back-to-back mounting. Provide air inlet filters.

B. Enclosure: (Exterior) Standard components and optional features shall be housed in a NEMA 3R enclosure.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Selector Switches: NEMA ICS 2, heavy-duty type. Provide as required.

C. Control Relays: Auxiliary and adjustable time-delay relays. Provide as required.

D. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
   3. Motor current (amperes).
   4. DC-link voltage (VDC).
   5. Motor torque (percent).
   6. Motor speed (RPM).
   7. Motor output voltage (V).

E. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VSD’s before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VSD’s for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VSD installation.

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

3.2 APPLICATION

A. Select features of each VSD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load.
   1. Refer to individual Sections in Division 23 for mechanical equipment requirements.

B. Select rating of controllers to suit motors controlled.

C. Assume single source responsibility for compatibility of VSD’s with furnished equipment and systems and with load application.

3.3 INSTALLATION

A. Installation: Roughing-in and installation of VSD’s is specified in Division 26 Sections.
   1. Assure proper placement of VSD and proper electrical roughing-in.
   2. Comply with mounting and anchoring requirements specified in Division 26 Sections.

3. Mount units directly on walls, or on freestanding supports as indicated. Do not install on mechanical equipment.
4. Locate VSD's not more than 50 feet from, and within sight of the controlled motor. Provide clearances required for electrical equipment.

3.4 CONNECTIONS

A. Electrical Power Supply Wiring: Coordinate the installation and connection of power supply wiring.
   1. Power supply wiring from the power source to the VSD and from the VSD to the controlled motor, including any field-installed disconnects, and required electrical devices is Work of Division 26. Refer to Division 26 Sections for requirements.
   2. The load side wiring between the VSD and the controlled motor shall be within a separate dedicated electrical conduit.
   3. Assure correct fuses are installed in each fusible switch.
   4. Assure equipment is grounded according to Division 26 requirements.

B. Building Management System/Automatic Control System Interface: Coordinate the installation and connection of automatic controls and control devices.
   1. Refer to Division 23 Sections "Automatic Control System" and "Automatic Control Sequences" for control devices, control interfaces and specified control sequences.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VSD's and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each VSD element, bus, component supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Assist in field testing of equipment including pre-testing and adjusting of solid-state controllers.
   3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   4. Startup report will indicate test results and confirm that the installation meets the manufactures installation instructions and the requirements of this section.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable speed drives. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Equipment supports.

B. Related Sections:
   1. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1.5 ACTION SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

2.2 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
      a. Allied Tube & Conduit. (www.alliedtube.com)
      b. Cooper B-Line, Inc. (www.cooperindustries.com)

c. Flex-Strut Inc. (www.flexstrut.com)
d. Thomas & Betts Corporation. (www.tnb.com)
e. Unistrut Corporation; Tyco International, Ltd. (www.unistrut.com)
f. Wesanco, Inc. (www.wesanco.com)

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

2.3 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.4 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

C. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

D. 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.

E. Install lateral bracing with pipe hangers and supports to prevent swaying.

F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 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.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting"; Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

E. Use stainless-steel pipe hangers and [stainless-steel attachments for hostile environment applications.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
3. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
5. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   5. C-Clamps (MSS Type 23): For structural shapes.
   6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
   9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
   10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
   11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

END OF SECTION

SECTION 230548
VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Elastomeric isolation pads.
   2. Housed-spring isolators.
   3. Open-spring isolators.
   4. Spring Hangers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

PART 2 PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Company Incorporated (www.acemount.com)
      b. California Dynamics Corporation (www.caldyn.com)
      c. Isolation Technology Incorporated (www.isolationtech.com)
      d. Kinetics Noise Control, Incorporated (www.kineticsnoise.com)
      e. Mason Industries, Incorporated (www.mason-ind.com)
      f. Vibration Eliminator Company Incorporated (www.veco-ny.com)
      g. Vibration Isolation (www.vibrationiso.com)
   2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
   3. Size: Factory or field cut to match requirements of supported equipment.
   4. Pad Material: Oil and water resistant with elastomeric properties.
   5. Surface Pattern: Smooth, Ribbed or Waffle pattern.
   6. Infused nonwoven cotton or synthetic fibers.
   7. Sandwich-Core Material: Resilient.

2.2 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: **Type F**
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Company Incorporated (www.acemount.com)
      b. California Dynamics Corporation (www.caldyn.com)
      c. Isolation Technology Incorporated (www.isolationtech.com)
      d. Kinetics Noise Control, Incorporated (www.kineticsnoise.com)
      e. Mason Industries, Incorporated (www.mason-ind.com) Example: SSLFH
      f. Vibration Eliminator Company Incorporated (www.veco-ny.com)
      g. Vibration Isolation (www.vibrationiso.com)

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. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Top housing with attachment and leveling bolt.

2.3 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Company Incorporated (www.acemount.com)
      b. California Dynamics Corporation (www.caldyn.com)
      c. Isolation Technology Incorporated (www.isolationtech.com)
      d. Kinetics Noise Control, Incorporated (www.kineticsnoise.com)
      e. Mason Industries, Incorporated (www.mason-ind.com) Example: SLF
      f. Vibration Eliminator Company Incorporated (www.veco-ny.com)
      g. Vibration Isolation (www.vibrationiso.com)
   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. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
   7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.4 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Company Incorporated (www.acemount.com)
      b. California Dynamics Corporation (www.caldyn.com)
      c. Isolation Technology Incorporated (www.isolationtech.com)
      d. Kinetics Noise Control, Incorporated (www.kineticsnoise.com)
      e. Mason Industries, Incorporated (www.mason-ind.com) Example: 30N
      f. Vibration Eliminator Company Incorporated (www.veco-ny.com)
      g. Vibration Isolation (www.vibrationiso.com)
   2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 FACTORY FINISHES

A. Vibration controls installed outdoors or in wet indoor locations will have Hot-dip galvanize metal components; all other vibration controls will have the manufacturer's standard prime-coat finish ready for field painting.

3.3 PERFORMANCE OF ISOLATORS

A. General: Comply with minimum static deflections indicated on the Drawings and Schedules. If not indicated, comply with minimum static deflections as recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturers' Recommendations: Except as indicated, comply with manufacturers' recommendations for selection and application of vibration isolation materials and units.

3.4 VIBRATION CONTROL DEVICE INSTALLATION

A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.5 ADJUSTING

A. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

B. Adjust active height of spring isolators.

3.6 CLEANING

A. After completing equipment installation, inspect vibration isolation control devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Duct labels.

1.3 ACTION SUBMITTALS

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

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: Black.
   3. Background Color: White.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semi rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1/2 inch high.

2.3 DUCT LABELS

A. General Requirements for Manufactured duct Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch tall.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to [25 feet] in areas of congested piping and equipment.

B. Pipe Label Color Schedule:
   1. Natural Gas Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
   1. Yellow: For hot-air supply ducts.
   2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
   3. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet.

END OF SECTION

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Balancing constant volume air systems.
   2. Verifying that automatic control devices are functioning properly.
   3. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including sub mains, 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. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

F. Report Forms: Test data sheets for recording test data in logical order.

G. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

H. 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.

I. TAB: Testing, adjusting, and balancing.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of systems or equipment.

L. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

M. AABC: Associated Air Balance Council.

N. NEBB: National Environmental Balancing Bureau.

O. TAB: Testing, adjusting, and balancing.

P. TABB: Testing, Adjusting, and Balancing Bureau.

Q. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

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.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by either AABC or NEBB.

1. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

B. TAB Conference: Meet with Architect and Owners representatives on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:
   a. The Contract Documents examination report.
   b. The TAB plan.
   c. Coordination and cooperation of trades and subcontractors.

C. Coordination of documentation and communication flow. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's " Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, "Section II, " Required Instrumentation for NEBB Certification."

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.

G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

H. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

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 curves.

1. 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.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine operating safety interlocks and controls on HVAC equipment.

J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following: 7

1. Permanent electrical-power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance dampers are open.
5. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in this Section.

B. Cut ducts and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 "Air Duct Accessories."
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 "Duct Insulation," and Division 23 "HVAC Equipment Insulation"

C. Mark equipment and balancing devices, including damper-control positions with paint or other suitable, permanent identification material to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check for proper sealing of air-handling-unit components.

J. Verify that air duct system is sealed as specified in Division 23 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
2. Measure fan static pressures as follows to determine actual static pressure:
    a. Measure outlet static pressure as far downstream from the fan as practical 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 the 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.
3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    a. Report the cleanliness status of filters and the time static pressures are measured.
4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

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 mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure airflow of submain and branch ducts.
      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. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
   3. Remeasure 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 air 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 air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch 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.

3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   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 of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.7 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.

3.8 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 progress prepare progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Fan curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   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 supervisor 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's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fan performance forms including the following:
      a. Settings for outdoor-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Fan drive settings including settings and percentage of maximum pitch diameter.
      d. Other system operating conditions that affect performance.

D. 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 outdoor, supply, return, and exhaust airflows.
   2. Duct, outlet, and inlet sizes.
   3. Terminal units.
   4. Balancing stations.
   5. Position of balancing devices.

E. 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 (mm), and bore.
      i. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
      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. Sheave make, size in inches (mm), and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
   e. Filter static-pressure differential in inches w.g.
   f. Outside airflow in cfm.
   g. Return airflow in cfm.
   h. Outside-air damper position.
   i. Return-air damper position.

F. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Fuel type in input data.
   g. Output capacity in Btuh.
   h. Ignition type.
   i. Burner-control types.
   j. Motor horsepower and rpm.
   k. Motor volts, phase, and hertz.
   l. Motor full-load amperage and service factor.
   m. Sheave make, size in inches, and bore.
   n. Sheave dimensions, center-to-center, and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Entering-air temperature in degrees F.
   c. Leaving-air temperature in degrees F.
   d. Air temperature differential in degrees F.
   e. Entering-air static pressure in inches w.g.
   f. Leaving-air static pressure in inches w.g.
   g. Air static-pressure differential in inches w.g.
   h. Low-fire fuel input in Btuh.
   i. High-fire fuel input in Btuh.
   j. Manifold pressure in psig.
   k. High-temperature-limit setting in degrees F.
   l. Operating set point in Btuh.
   m. Motor voltage at each connection.
   n. Motor amperage for each phase.
   o. Heating value of fuel in Btuh.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.

f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   g. Number of belts, make, and size.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches w.g.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
   e. Suction static pressure in inches w.g.

H. 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 degrees F.
   d. Duct static pressure in inches w.g.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air-terminal-device make.
   f. Air-terminal-device number from system diagram.
   g. Air-terminal-device type and model number.
   h. Air-terminal-device size.
   i. Air-terminal-device effective area in sq. ft.
2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in degrees F.
3. Observed deficiencies.

J. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.

e. Dates of calibration.

3.10 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. Check the following for each system:
   a. Measure airflow of at least 10 percent of air outlets.
   b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   c. Verify that balancing devices are marked with final balance position.
   d. Note deviations from the Contract Documents in the final report.

B. Prepare test and inspection reports.

C. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION

SECTION 230713
DUCT INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, exposed outdoor air.
   2. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Sections:
   1. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.3 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required. Insulation application may begin on segments that have satisfactory test results.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FRK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.4 TAPES

A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.

5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.5 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.105-inch- diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the following:
      (a) AGM Industries, Inc.; CWP-1.
      (b) GEMCO; CD.
      (c) Midwest Fasteners, Inc.; CD.
      (d) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.105-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      (a) AGM Industries, Inc.; CHP-1.
      (b) GEMCO; Cupped Head Weld Pin.
      (c) Midwest Fasteners, Inc.; Cupped Head.
      (d) Nelson Stud Welding; CHP.

B. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. GEMCO.
   b. Midwest Fasteners, Inc.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not over compress insulation during installation.
      e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
   5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, exposed outdoor air.
   2. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:
   1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   2. Factory-insulated access panels and doors.

3.7 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, rectangular, outdoor-air duct insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

B. Exposed, rectangular exhaust-air duct shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

END OF SECTION

SECTION 230900
INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control equipment for plumbing and HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
   1. Refer to Division 21, 22, and 23 sections for required control and alarm points.

B. All control work to be a modification and extension of building existing Johnson Controls, Inc. “Metasys” Direct Digital Control System.

C. Related Sections include the following:
   1. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

D. Refer to Division-26 Sections for the following work.
   1. Power from the power source to the power connection on control panels as indicated on the Electrical Drawings.
   2. Interlock wiring between electrically operated equipment units, and between equipment and field-installed control devices as indicated on the Electrical Drawings.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LAN: Local area network.

D. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

E. MS/TP: Master slave/token passing.

F. PC: Personal computer.

G. PICS: Protocol Implementation Conformance Statement.

H. PID: Proportional plus integral plus derivative.

I. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
   3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
   4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
   5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   a. Space Temperature: Plus or minus 1 degrees F.
   b. Ducted Air Temperature: Plus or minus 1 degrees F.
   c. Outside Air Temperature: Plus or minus 2 degrees F.
   d. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   e. Natural Gas: Plus or minus 5 percent of reading.
   f. Carbon Monoxide; Plus or minus 5 percent of reading.

1.5 SEQUENCE OF OPERATION

A. Refer to Division 23 specification section “Sequence of Operation for HVAC Controls”.

1.6 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated; and indicate where it will be applied.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
   3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, dampers, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Written description of sequence of operation.
   6. Schedule of dampers including size, leakage, and flow characteristics.
   7. DDC System Hardware:
      a. Wiring diagrams for control units with termination numbers.
      b. Schematic diagrams and floor plans for field sensors and control hardware.
      c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   9. Controlled Systems:
      a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      c. Written description of sequence of operation including schematic diagram.
      d. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

E. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
   2. Interconnection wiring diagrams with identified and numbered system components and devices.
   3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
   4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   5. Calibration records and list of set points.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

G. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Startup Personnel Qualifications: Specially trained personnel, in the direct employ of manufacturer or franchise of the primary automatic-control-system provider, who are experienced with the installation and startup of automatic control systems installations similar to those required for this Project.

D. Codes and Standards: Equipment, materials, and labor; provided as work of this section shall comply with federal, state, and local standards, codes, and ordinances.

E. Comply with ASHRAE 135 for DDC system components.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.

B. Coordinate the location and installation of automatic control dampers and instruments. Automatic control dampers and instruments will be installed according to Division 23 Section Duct Accessories.

C. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

E. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

F. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

G. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

1.10 WARRANTY

A. Components, system software, parts and assemblies will be guaranteed against defects in materials and workmanship for two years from the acceptance date.

B. Labor and material to troubleshoot, repair, reprogram, or replace system components will provide, at no charge to the owner during the warranty period.

C. Corrective software modifications made during warranty service periods will be updated on all user documentation and on user and manufacturer archived software disks. Provide the owner with a new compact disc whenever software changes are required.

D. The installer will be capable of doing any repairs with factory trained technicians operating out of a local service office.

E. The installer will furnish the Owner with a local telephone number where a factory-trained technician may be reached at all times.

F. The factory-trained technician will arrive at the job-site ready to service the system within two hours upon receiving a request for repairs and will prosecute the work continuously until the system is back in proper reliable operating condition.

G. The installer will keep a permanent maintenance record at the local service office of all repairs performed and all service calls responded to during the warranty period (including labor and material used); copy of record will be presented to Owner's representative at completion of each service call.

H. Permanent maintenance records will include all dial-up-type service calls made via the dial-up communications feature.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

2.2 INSTALLERS

A. Installers: Subject to compliance with requirements, automatic control systems will be installed by the following:

1. Johnson Controls, Corporate Controls Group

2.3 CONTROL SYSTEM

A. Manufacturers:

1. Johnson Controls, Incorporated; Controls Group.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.4 DDC EQUIPMENT

A. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.

b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

B. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

C. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.second response time for 50 percent load changes.
3. Built-in over-voltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

D. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.5 OPERATOR WORKSTATION INTERFACE

A. Basic Interface Description

1. Operator workstation interface software will minimize operator training using English language prompting, 30 character English language point identification, on-line help, and industry standard PC application software. The software will provide, as a minimum, the following functionality:
   a. Real-time graphical viewing and control of environment
   b. Scheduling and override of building operations
   c. Collection and analysis of historical data
   d. Point database editing, storage and downloading of controller databases.
   e. Alarm reporting, routing, messaging, and acknowledgment
   f. Display dynamic data trend plot.
      1) Must be able to run multiple plots simultaneously
      2) Each plot must be capable of supporting 10 pts/plot minimum
      3) Must be able to command points directly off dynamic trend plot application.
   g. Definition and construction of dynamic color graphic displays.
   h. Program editing
   i. Transfer trend data to third party software
   j. Scheduling reports
   k. Operator Activity Log

2. Provide a graphical user interface that will minimize the use of keyboard with a mouse or similar pointing device and "point and click" approach to menu selection.
3. The software will provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software will run on a Windows XP Professional operating system. These Windows applications will run simultaneously with the BAS software. The mouse will be used to quickly select and switch between multiple applications. The operator will be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information.
    a. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows. Operator will be able to drag and drop information between applications, reducing the number of steps (i.e. Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend).
        1) Dynamic color graphics and graphic control
        2) Alarm management, routing to designated locations, and customized messages
        3) Year in advance event and report scheduling
        4) Dynamic trend data definition and presentation
        5) Graphic definition and construction
        6) Program and point database editing on-line.
    b. Report and alarm printing will be accomplished via Windows Print Manager, allowing use of network printers.
    c. Operator specific password access protection will be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges will "follow" the operator to any workstation logged onto (up to 999 user accounts will be supported).
4. Reports will be generated on demand or via pre-defined schedule and directed to CRT displays, printers, or disk. As a minimum, the system will allow the user to easily obtain the following types of reports:
    a. A general listing of all or selected points in the network
    b. List of all points currently in alarm
    c. List of all points currently in override status
    d. List of all disabled points
    e. List of all points currently locked out
    f. List of user accounts and access levels
    g. List all weekly schedules
    h. List of holiday programming
    i. List of limits and deadbands
    j. Custom reports from third party software
    k. System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
    l. List of programs
5. Scheduling and Override: Provide a calendar type format for simplification of time-of-day scheduling and overrides of building operations. Schedules reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line; PC is not required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphic types as a minimum:
    a. Weekly schedules
    b. Zone schedules, minimum of 200 unique zones
    c. Scheduling for up to 365 days in advance
    d. Schedule reports to print at PC.
6. Collection and Analysis of Historical Data
    a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period. Any system point may be trended automatically at time-based intervals or change of value, both of which will be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

b. Trend data reports will be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor will provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor will provide setup of custom reports including creation of data format templates for monthly or weekly reports.
c. Provide additional functionality that allows the user to view real-time trend data on trend graph displays. A minimum of ten points may be graphed, regardless of whether they have been predefined for trending. The dynamic graphs will continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of 8 true graphs will run simultaneously. Operator will be able to command points directly on the trend plot by double clicking on the point.
d. Provide trend reports for the following data: (Each air handling unit)
    1) Duct static pressure.
    2) Supply fan cfm.
    3) Return fan cfm.
    4) Outside air cfm.
    5) Discharge air temperature.
    6) Return air temperature.

B. Dynamic Color Graphic Displays
1. Create color graphic floor plan displays and system schematics for each piece of mechanical equipment to optimize system performance analysis and speed alarm recognition. Color graphic displays will include the following:
    a. Start, Stop, and Status for HVAC equipment.
    b. Start, Stop, and Status for plumbing equipment.
    c. Make Up Air-handling Units
        1) Measured air flow; Outside air.
        2) Outside air flow set point.
        3) Measured air temperatures; Outside air and supply air.
        4) Measured space temperature
        5) Space temperature set point.
2. Operator Override: The system shall allow the operator to override control sequences and drive open or closed all automatic control dampers and valves.
3. Two position dampers and control valves shall be shown as “OPEN” or CLOSED.”
4. Modulating dampers shall be displayed as a percentage of full open. Zero percent equals closed, and 100-percent equal’s full open.
5. The operator interface will allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands. Graphics software will permit the importing of AutoCAD or scanned pictures for use in the system.
6. Dynamic temperature values, flow values and status indication will be shown in their actual respective locations and will automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
    a. Sizable analog bars will be available for monitor and control of analog values; high and low, alarm limit settings will be displayed on the analog scale. The user will be able to "click and drag" the pointer to change the set point.
    b. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions will be displayed by flashing point blocks.
    c. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or set point.
    d. State text for digital points can be defined up to eight characters.
7. Colors will be used to indicate status and change as the status of the equipment changes. The state colors will be user definable.
    a. “Green” will always represent normal operation.
    b. Alarms will be “red”.

c. Manual Maintenance Mode: Motors that have been manually switched off by the system operator will be “Yellow”.

8. A dynamic display of the site-specific architecture showing status of controllers, PC workstations, and networks will be provided.

C. Alarm Management

1. Alarm Routing will allow the user to send alarm notification to selected printers or PC location based on time of day, alarm severity, or point type.
2. Alarm Notification will be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. These alarm icons will be displayed when user is working in other Windows programs. The BAS alarm display screen will be displayed when the user clicks on the alarm icon.
3. Alarm Display will list the alarms with highest priority at the top of the display. The alarm display will provide selector buttons for display of the associated point graphic and message. The alarm display will provide a mechanism for the operator to sort alarms.
4. Alarm messages will be customizable for each point to display detailed instructions to the user regarding actions to take in case of an alarm.

2.6 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72 -hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. Enclosure: Dustproof rated for operation at 32 to 120 degrees F.

2.7 DDC RESIDENT SOFTWARE FEATURES

A. General:

1. The software programs specified in this section will be provided as an integral part of the DDC and HVAC mechanical equipment controllers and will not be dependent upon any higher level computer (or operator workstation) for execution.
2. All points will be identified by up to 30-character point name and 16 character point descriptor. The same names will be used at the operator workstation.
3. All digital points will have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter)).

B. Control Software Description:

1. The DDC and HVAC mechanical equipment controllers will have the ability to perform the following pre-tested control algorithms:
   a. Two-position control
   b. Proportional control
   c. Proportional plus integral control
   d. Proportional, integral, plus derivative control
   e. Automatic tuning of control loops

C. DDC and HVAC mechanical equipment controllers will provide the following energy management routines.

1. Start-Stop Time Optimization (SSTO) will automatically be coordinated with event scheduling. The SSTO program will start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program will also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
    a. The SSTO program will operate in both the heating and cooling seasons.
    b. It will be possible to apply the SSTO program to individual fan systems.
    c. The SSTO program will operate on both outside weather conditions as well as inside zone conditions and empirical factors.
    d. The SSTO program will meet the local code requirements for minimum outside air while the building is occupied.
2. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
    a. It will be possible to individually command a point or group of points.
    b. For points assigned to one common load group, it will be possible to assign variable time delays between each successive start or stop within that group.
    c. The operator will be able to define the following information:
        1) Time, day
        2) Commands such as on, off, auto, and so forth.
        3) Time delays between successive commands.
    d. There will be provisions for manual overriding of each schedule by an appropriate operator.
    e. It will be possible to schedule events up to one year in advance.
        1) Scheduling will be calendar based.
        2) Holidays will allow for different schedules.
3. Automatic Daylight Savings Time Switchover: The system will provide automatic time adjustment for switching to/from Daylight Savings Time.
4. Night setback control: The system will provide the ability to automatically adjust set points for night control.
5. The Peak Demand Limiting (PDL) program will limit the consumption of electricity to prevent electrical peak demand charges.
    a. PDL will continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
    b. PDL will sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
    c. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, and then PDL will automatically shed electrical loads.
    d. Once the demand peak has passed, loads that have been shed will be restored and returned to normal control.

D. DDC and HVAC Mechanical Equipment Controllers will be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
1. A single process will be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process will be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database will support 30 character; English language point names, structured for searching, and logs.
2. Processes will be able to generate operator messages and advisories to operator I/O devices. A process will be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
3. DDC and HVAC Mechanical Equipment Controller will provide a HELP function key; providing enhanced context sensitive on-line help with task orientated information from the user manual.
4. DDC and HVAC Mechanical Equipment Controller will be capable of comment lines for sequence of operation explanation.

E. Alarm management will be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller will 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 will the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device, or communications with other panels on the network.

1. All alarm or point change reports will include the point's English language description and the time and date of occurrence.
2. The user will be able to define the specific system reaction for each point. Alarms will be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels will be provided for each point. Point priority levels will be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller will automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users will have the ability to manually inhibit alarm reporting for each point.
3. Alarm reports and messages will be directed to a user-defined list of operator devices or PC's based on time (after hours destinations) or based on priority.
4. In addition to the point's descriptor and the time and date, the user will be able to print, display, or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
5. In dial-up applications, operator-selected alarms will initiate a call to a remote operator device.
6. Alarm points will be individually addressed. Do not group alarm points.

F. A variety of historical data collection utilities will be provided to manually or automatically sample, store, and display system data for points as specified in the I/O summary.

1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection will be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days will be provided. Each DDC and HVAC Mechanical Equipment Controller will have a dedicated RAM-based buffer for trend data and will be capable of storing data samples. All trend data will be available for transfer to a Workstation without manual intervention.
2. DDC and HVAC Mechanical Equipment Controllers will also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms will be provided for operator-selected PID control loops as identified in the point I/O summary.
3. Loop tuning will be capable of being initiated both locally at the DDC and at HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop-tuning functions, access will be limited to authorized personnel through password protection.

G. DDC and HVAC Mechanical Equipment Controllers will be capable of automatically accumulating and storing run-time hours. For digital input and output points, and automatically sample, calculate, and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.

H. The peer to peer network will allow the DDC and HVAC Mechanical Equipment Controllers to access, any data from, or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller. Or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers will send alarm reports to multiple workstations without dependence upon a central or intermediate-processing device. The peer to peer network will also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.

I. The peer to peer network will allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The log on password (at any PC workstation or portable operator terminal) will enable the operator to monitor, adjust, and control the points that the operator is authorized to access. All other points will not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points will be accessible to any base building operators, but only tenant points will be accessible to tenant building operators). Passwords and priorities for every point will be fully programmable and adjustable.

2.8 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
   1. Alarm Condition: Indicating light flashes and horn sounds.
   2. Acknowledge Switch: Horn is silent and indicating light is steady.
   3. Second Alarm: Horn sounds and indicating light is steady.
   4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
   5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.9 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:
   1. Manufacturers:
      a. BEC Controls Corporation.
      b. Ebtron, Incorporated
      c. Heat-Timer Corporation.
      d. I.T.M. Instruments Incorporated
      e. Kele Incorporated
      f. MAMAC Systems, Incorporated
      g. Precon; Division of Kele Incorporated.
      h. RDF Corporation.
      i. Veris Industries
   2. Accuracy: Plus or minus 0.36 degrees F at calibration point.
   3. Wire: Twisted, shielded-pair cable.
   4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 square feet.
   5. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

2.10 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch water gage.

B. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

C. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

D. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.11 GAS DETECTION EQUIPMENT

A. Manufacturers:
   1. Critical Environment Technologies

2. Honeywell International Incorporated; Home & Building Control.
3. Vulcain Incorporated

B. Carbon Monoxide Detectors: Single or multi-channel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of minus 20 to 104 degrees F; zero to 250 ppm.

C. Natural Gas Detectors: Single or multi-channel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of minus 20 to 104 degrees F; zero to 250 ppm.

2.12 AIR FLOW MEASURING STATIONS (AFMS)

A. Duct Airflow Station: Multi-point "bead in glass" Thermistor sensors mounted in anodized 6061 aluminum alloy tubes.
1. Manufacturers:
   a. Ebtron.
2. Gold Series Model GTA116-PC.
3. Accuracy: 2-percent of actual air flow.
4. Operating Temperature: -20^{o}F to 160^{o}F.
5. Monitoring Velocity Range: 0 FPM to 5000 FPM.
6. Digital Transmitter with BACnet MS/TP or Modbus RTU communication capable of transmitting average air temperature (deg. F), velocity (FPM) and air flow (CFM).

2.13 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Manufacturers:
   a. Belimo Aircontrols (USA), Incorporated
   b. Bray International Incorporated.
   c. Delta Control Products.
   d. Honeywell, Incorporated; Home & Building Control.
   e. Siemens Building Technologies
   f. Johnson Controls, Incorporated; Controls Group.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
   a. Run Time: Hydronic terminal units 3-inches and smaller: 90 seconds open, 90 seconds closed.
3. Dampers: Size for running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
   e. Dampers with 2- to 3-Inch w.g of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch w.g of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 120-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 degrees F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 degrees F.
12. Run Time: 12 seconds open, 5 seconds closed.

2.14 DAMPERS

A. Manufacturers: Manufacturers: Subject to compliance with requirements, provide control damper products by one of the listed manufacturers:
   1. Arrow United Industries
   2. Belimo Aircontrols (USA), Incorporated
   3. Cesco Products
   4. Honeywell, Incorporated; Home & Building Control.
   5. Johnson Controls, Incorporated; Controls Group.
   6. Ruskin Manufacturing Company
   7. Siemens Building Technologies
   8. Vent Products Co., Incorporated

B. Construction:
   1. Frames: Extruded aluminum hat channels, 0.125-in. minimum thickness.
   2. Blades: Extruded aluminum airfoil type, 6-inch maximum blade width.
   3. Hardware: Molded synthetic bearings. Zinc plated steel axles, linkage brackets, connecting rods, and mounting bolts.
   4. Seals: Flexible metal compression seals on the frame at blade end; extruded vinyl inflatable blade edge seals.
   5. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

C. Operating Limits:
   1. Temperature: -20 to 200 degrees F.
   2. Pressure: 6 inches w.g. differential.
   3. Velocity: Up to 4000 FM.

D. Select Parallel blade dampers for proportional service. Opposed blade dampers shall be used for two-position service.

E. Damper sizes will be provided as indicated on the drawings. Damper sizes may be provided differently from those shown on the drawings, if improved performance can be demonstrated with calculations.

2.15 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units.

3.2 INSTALLATION

A. Install equipment level and plumb.

B. Install software in control units and operator workstations. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Verify location of temperature sensors, thermostats, and other exposed control sensors with Drawings and room details before installation.
   1. Install adjustable devices 48 inches above the floor.
   2. Install non-adjustable devices 60 inches above the floor.

E. Install room thermostats where indicated on the drawings.

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

H. Install duct mounted air flow measuring stations according to the manufacturer's instructions. Comply with manufactures mounting requirements to achieve specified instrument accuracy.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

1. Wiring exposed to view, or concealed: Run wiring within electric metallic tubing.
2. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
3. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
4. Provide enclosures for terminal strips and similar devices.

D. Install power supply wiring in addition to, or different from electrical power supply wiring specifically shown on the electrical drawings. Include disconnects, and required electrical devices. Power supply wiring for controls will extend from separate circuits on emergency power panels located as indicated on the electrical drawings.

E. Install control wiring between field-installed sensing and control devices controlled equipment and unit control panels. Include disconnects, and required electrical devices.

F. Install interlock wiring between electrically-operated equipment units, and between equipment and field installed control devices in addition to, or different from, interlock wiring specifically shown on the electrical drawings.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check DDC system as follows:
   a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   b. Verify that spare I/O capacity has been provided.
   c. Verify that DDC controllers are protected from power supply surges.
5. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
6. Verify operation of operator workstation.
7. Verify local control units including self-diagnostics.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Control System Inputs and Outputs:
      a. Check analog inputs at 0, 50, and 100 percent of span.
      b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
      c. Check digital inputs using jumper wire.
      d. Check digital outputs using ohmmeter to test for contact making or breaking.
      e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
   5. Temperature:
      a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
      b. Calibrate temperature switches to make or break contacts.
   6. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
   7. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
   8. Provide diagnostic and test instruments for calibration and adjustment of system.
   9. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory service representative to demonstrate, to the owner and engineer, that all system components have been calibrated and adjusted and are functioning properly.

B. Engage a factory service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
   1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
   2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours' dedicated instructor time on-site.
   3. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Submittals."
   4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.7 TRAINING

A. The manufacturer will provide training for the Owner's building personnel in procedures for start-up, testing and operating the Automatic Control System.

B. Provide on-site operator instruction during normal working hours. Instruction will be performed by experienced factory trained technical representatives familiar with the overall system's software, hardware and accessories. Provide a minimum of forty (20) hours of on-site training for three (3) of the Owner's designated operating personnel.

END OF SECTION

SECTION 230993
SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control sequences for HVAC and plumbing systems, subsystems, and equipment.
   1. Temperature and pressure set points listed shall be adjustable.
   2. Provide the building automation system operator with manual over-ride for automatic control valves and dampers. The over-ride shall allow the operator to command open or close valves and dampers.

B. Related Sections include the following:
   1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

A. Air terminal damper open: The damper will open to the scheduled maximum air flow.

B. Damper or valve full open: Damper or valve will be 100 percent open.

C. DDC: Direct digital control.

D. Modulate: Proportionally position.

E. Set points: Set points will be operator adjustable unless noted as fixed.

F. Temperature: Air and liquid temperatures are in degrees F.

G. VAV: Variable air volume.

1.4 TIME SCHEDULE

A. HVAC and designated plumbing equipment will be scheduled for occupied and unoccupied status.

B. The daily scheduler will allow the system operator to switch between occupied and unoccupied status a minimum of five times per day. Holidays and weekends will be scheduled separately.

C. The initial schedule will incorporate HVAC and designated plumbing equipment. Coordinate the initial scheduled occupied/unoccupied hours with the owner and incorporate the schedules before substantial completion.

1.5 MAKEUP AIR UNIT CONTROL SEQUENCES (MAU-1 AND MAU-2)

A. General: Make up air unit will be started and stopped by the DDC system programmed occupied/unoccupied time schedule and unit controller.

B. The makeup air units shall be controlled from unit manufacturer's factory installed packaged controls. The DDC system shall monitor status of each unit operation including all control points available from units. Refer to Division 23 specification section "Indoor, Indirect, Gas-Fired Heating and Ventilating Units" for list of available points.

C. Ventilation Air Control:
   1. Minimum outdoor air ventilation shall be maintained with an air flow measuring station located in the outdoor air duct and modulation of supply fan VSD controller varying fan speed to maintain outdoor airflow setpoint. When outdoor airflow increases above setpoint, the VSD

shall reduce fan speed to maintain setpoint. When outdoor airflow decreases below setpoint, the VSD controller shall increase fan speed to maintain setpoint.

2. Minimum outdoor air flow setpoint shall be reset based on status of manually started engine exhaust hose reel fan operation. Minimum outdoor air flow setpoint shall be increased equal to the sum total of scheduled CFM values for each manually started operating engine exhaust hose reel fan.

1.6 VENTILATION SEQUENCES

A. General Garage Exhaust Fans (EF-1 and EF-2):
   1. General: The exhaust fan will be started and stopped by the DDC system programmed occupied/unoccupied time schedule and VSD controller.
   2. Emergency Operation: Natural gas and/or carbon monoxide gas detection systems shall override DDC system programmed occupied/unoccupied time schedule and operate exhaust fans upon detection of either gas levels above setpoint.
   3. Fan Status Current Switch: Monitoring of current draw integral to fan VSD shall be used to monitor loss of coupled load. The current switch set up shall be redone by the DDC contractor after the balancer is complete.
   4. Exhaust Fan Balancing: Balancing of exhaust fan air flow rate shall be done through the VSD controller. DDC contractor shall coordinate with the balancing contractor to optimize this setting.
   5. When exhaust fan is on, motor operated exhaust damper in exhaust duct shall open. When exhaust fan is off, motor operated exhaust damper shall close. Motor operated exhaust damper end switche shall be provided and monitored by the DDC system. Wire damper end switch into the DDC system so that the damper is proven open before the exhaust fan is allowed to start.

B. Engine Exhaust Hose Reel Fan: The exhaust fan will be manually started and stopped by the hose reel manufacturers drop cord accessory. DDC system shall monitor status of fan for adjustment to make up air units minimum outdoor air intake set point.

PART 2 PRODUCTS

PART 3 EXECUTION

END OF SECTION

SECTION 231123
FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Compressed Natural Gas System (CPG): Systems that operate at pressures exceeding 60-psig to as high as 3200-psig.

E. Low Pressure Gas System (LPG): Systems that operate at pressures not exceeding 14-inches water column.

F. Medium Pressure Gas System (MPG): Systems that operate at pressures greater than 14-inches water column and not greater than 5 psig.

G. High Pressure Gas System (HPG): Systems that operate at pressures greater than 5-psig.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 125 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.
   2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   3. Pressure regulators. Indicate pressure ratings and capacities.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Welding certificates.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.10 PROJECT CONDITIONS

A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than [two] days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.11 COORDINATION

A. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.2 PIPING SPECIALTIES

A. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   4. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BrassCraft Manufacturing Company; a Masco company. (www.brasscraft.com)
      b. Conbraco Industries, Incorporated; Apollo Division (www.apollovalves.com)
      c. Lyall, R. W. & Company, Incorporated (www.rwlyall.com)
      d. McDonald, A. Y. Mfg. Co. (www.aymcdonald.com)
   2. Body: Bronze, complying with ASTM B 584.
   3. Ball: Chrome-plated bronze.
   4. Stem: Bronze; blowout proof.
   5. Seats: Reinforced TFE; blowout proof.
   6. Packing: Threaded-body pack nut design with adjustable-stem packing.
   7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   8. CWP Rating: 600 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

C. Bronze Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Lee Brass Company. (www.leebrass.com)
      b. McDonald, A. Y. Mfg. Co. (www.aymcdonald.com)
   2. Body: Bronze, complying with ASTM B 584.
   3. Plug: Bronze.
   4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   5. Operator: Square head or lug type with tamperproof feature where indicated.
   6. Pressure Class: 125 psig.
   7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for natural gas.
   2. Steel jacket and corrosion-resistant components.
   3. Elevation compensator.
   4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Actaris.

b. American Meter Company.
c. Eclipse Combustion, Incorporated (www.eclipsenet.com)
d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
e. Invensys. (www.invensys.com)
f. Maxitrol Company.
g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 5 psig.

2.6 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

1. Prohibited Locations:
   a. Do not install natural-gas piping in or through circulating air ducts, chimneys or gas vents (flues).
   b. Do not install natural-gas piping in solid walls or partitions.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

S. Do not use natural-gas piping as grounding electrode.

T. Install shut-off valve and strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.

3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless Dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3.7 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES 0.5 PSIG AND LESS

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.11 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES BETWEEN 0.5 PSIG AND 5 PSIG

A. Aboveground, distribution piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with steel welding fittings and welded joints.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

B. Valves in branch piping for single appliance shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

END OF SECTION

SECTION 233113
METAL DUCTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2-inces to plus 10-inches wg. Metal ducts include the following:
   1. Rectangular ducts and fittings.
   2. Single-wall, round and flat oval spiral-seam ducts and formed fittings.
   3. Duct liner.

B. Related Sections include the following:
   1. Refer to Division 7 Section "Joint Sealants" for fire-resistant sealants for use around duct penetrations and fire-smoke damper installations in fire-smoke rated floors, partitions, and walls.
   2. Refer to Division 8 Section "Access Doors" for wall and ceiling-mounted access doors for access to concealed ducts.
   3. Refer to Division 10 Sections “Louvers and Vents” for intake air, exhaust air, and relief air louvers connected to ducts and installed in exterior walls.
   4. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

A. Exposed Duct: Ducts that are visible; except in mechanical equipment rooms.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout would provide original design results without increasing system total pressure.

1.5 SUBMITTALS

A. Product Data: Include details of construction, materials, and dimensions of individual components, profiles, and finishes for the following items:
   1. Duct Transverse Joints.
   2. Liners and adhesives.
   3. Sealants and gaskets.
   4. Duct Connection Systems

B. Shop Drawings: Drawn to scale not smaller than 1/4 inch equals 1 foot. Show fabrication and installation details for the size and types of metal ducts in the Project.
   1. Duct fabrication, assembly, and installation details.
   2. Duct sizes and materials thickness for the various systems and duct pressure classes.
   3. Sealing class.
   4. Fittings.
   5. Reinforcement and spacing.
   6. Seam and joint construction.
   7. Penetrations through fire-rated and other partitions.
   8. Hangers and supports.

9. Methods for duct and building attachment.
10. Vibration isolation.
11. Plenums.

C. Coordination Drawings: Floor plans, or reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other and with the Work of other trades.
   1. Duct layout plans indicating size and pressure class. Include elevations and sections, as may be necessary to demonstrate coordination.
   2. Dimensions of main duct run from building grid lines.
   3. Elevations of top and bottom of ducts.
   4. Duct cross-over/under details.
   5. Equipment installation based on equipment being used on Project.
   6. Other systems installed in the same space as ducts.

D. Welding certificates.

E. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. NFPA Compliance:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thickness, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653 and having G90 coating designation.
   1. Ducts shall have mill-phosphatized “Paint-Grip” finish for surfaces of ducts exposed to view that are scheduled for field painting.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
   1. Black steel reinforcement may be used on galvanized sheet metal ducts and on aluminum or stainless steel ducts if painted with zinc-chromate primer prior to fabrication.

D. Tie Rods: Galvanized steel, 3/8-inch minimum diameter. Rigid conduit, minimum 3 /4-inch, can be used in accordance with referenced standards.

2.3 SEALANT MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   1. Ductmate Industries, Incorporated (PROseal & FIBERseal)

B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

C. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, use O.

D. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 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. Use powder-actuated concrete fasteners for standard-weight aggregate concrete's or for slabs more than 4 inches thick.
   2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concrete's or for slabs less than 4 inches thick.
   3. Exception: Do not use powder-actuated concrete fasteners in post-tensioned concrete slabs where the cable locations are not known. Fasteners shall not exceed 3/ 4-inch embedment.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
   1. Hanger's installed in Corrosive Atmospheres: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer prior to installation.
   2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

2.5 DUCT FABRICATION-GENERAL

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," and with the requirements of this Section.

B. Comply with SMACNA's "Rectangular Industrial Duct Construction Standards" for acceptable materials, material thickness, and duct construction methods outside the scope of SMACNA's "HVAC Duct Construction Standards-Metal and Flexible."

C. Duct Pressure Classification: Construct duct systems for the following pressure classifications:
   1. Supply Air Ducts: 2 inches water gage, positive pressure.
   2. Exhaust Air Ducts: 2 inches water gage, negative pressure.
   3. Other Ducts: 2 inches water gage positive or negative pressure.

D. Duct Sealing Classification: Provide SMACNA "Seal Class A" for all duct pressure classifications.
   1. Seal all transverse joints, longitudinal seams, and duct penetrations.
   2. Seal to achieve no visible or audible leaks.

E. Materials: All ducts shall be galvanized steel.

2.6 RECTANGULAR DUCT FABRICATION

A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals, and with the requirements of this Section.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
   3. Calculations: When duct construction is outside the scope of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," provide calculations to demonstrate compliance with Duct Pressure Classification.

B. Transverse Joints:
   1. Prefabricated Slide-On Joints and Components:
      a. Manufacturers:
         1) Ductmate Industries, Inc.

2) Elgen Manufacturing
3) Nexus Inc.
4) Ward Industries, Inc.

b. Apply joints using manufacturer's "Duct Construction Standards" for material thickness, reinforcement size and spacing, and joint reinforcement. "Duct Construction Standards" must be based on the referenced SMACNA Standards. "Duct Construction Standards" shall be submitted as shop drawings, and must be available upon request at the Project Site.
c. Slide-on joints must include the use of corners, bolts, cleats, and gaskets.
d. Gaskets must be suitable for application at temperatures experienced at the Project Site.

2. Formed-On Flanges:
a. Manufacturers:
1) Ductmate Industries Incorporated
2) Elgen Manufacturing
3) T.D.C.
4) T.D.F.
b. Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Table 1-12. Formed-on flanges shall be constructed as T-25A (T.D.C.) and T-25B (T.D.F.) joints.
c. Formed-on flanges must include the use of corners, bolts, cleats, and gaskets.
d. Gaskets must be suitable for application at temperatures experienced at the Project Site.
e. Duct Size: Maximum 42-inches wide and up to 4-inches wg pressure class.
f. Duct Size: Maximum 60-inches wide and up to 4-inches wg pressure class.

C. Longitudinal Seams: Pittsburgh-lock sealed with non-curing polymer sealant.

D. Internal Tie Rod Reinforcements: Do not use a transverse or intermediate reinforcement that requires the use of internal tie rods on ducts less than 96-inches wide.

E. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of non-braced panel area unless ducts are lined.

F. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division 23 section "Ductwork Accessories" for accessory requirements.

G. Fabricate ductwork so as to be free from vibration, rattling, or "oil-canning" under all operating conditions.

H. Unless otherwise indicated, the net free area of the duct dimensions given on the Drawings shall be maintained. The duct dimensions shall be increased as necessary to compensate for liner thickness.

2.7 RECTANGULAR DUCT FITTINGS

A. General: Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standards-Metal and Flexible," Figures 2-1 through 2-10.

B. Elbows and Divided Flow Fittings: Fabricate fittings with a centerline radius equal to 1.5 times the associated duct widths up to 28 inches wide, and 1.0 times the duct width for ducts 30 inches wide and wider. Figure 2-2; Type RE 1 radius elbow.

1. Where elbows with a shorter radius are necessary, fabricate elbows with a 4-inch throat radius, full radius heel, and with short radius vanes. Figure 2-2, Type RE-3. Fabricate short radius vanes according to Appendix pages A.41, A.42 and A.43.
2. Do not use square elbows, except where indicated on the Drawings. Where used, fabricate square elbow with single-wall turning vanes.

C. Transitions and Offsets: Limit concentric transitions to 45 degrees for diverging, and 60 degrees for converging; limit single-sided transitions to 22.5 degrees for diverging and 30 degrees for converging. Limit angled offsets to a maximum of 30 degrees.

D. Branch Connections: Fabricate branch connections according to Figure 2-6 using clinch lock joints and 45-degree entry.

2.8 ROUND AND FLAT-OVAL DUCT FABRICATION

A. Fabricate ducts according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," Tables 3-2 and 3-3.

B. Duct Pressure Classification and Duct Sealing Classification: As indicated in previous Article "Duct Fabrication, General."

C. Round and Flat Oval, Spiral-Lock-Seam Ducts 16-inches and larger:
   1. Manufacturers:
      a. McGill AirFlow Corporation.
      b. Semco Incorporated.
      c. Sheetmetal Connectors Incorporated.
   2. Fabricate round ducts with spiral lockseam. Figure 3-1, Type RL-1.
   3. Fabricate round ducts with longitudinal grooved seam. Figure 3-1, Type RL-5.
   4. Provide continuous butt-welded longitudinal seams on ducts larger than 72-inches, and where otherwise indicated. Figure 3-1, Type RL-4.

D. Transverse Duct Joints.
   1. Manufacturers:
      a. Ductmate Industries Incorporated.
      b. Elgen Manufacturing
      c. Semco Incorporated.
   2. Duct up to 20-Inches Diameter: Interior, center-beaded slip coupling. Figure 3-2, Type TR-1.
      a. Beaded crimp joints may be used for round duct diameters 14-inches and smaller for 2-Inch Duct Pressure Classifications. Figure 3-2, Type TR-5.
      b. Prefabricated self sealing gasketed coupler: Ductmate "Bullet Band".
   3. Ducts 21 to 72-Inches Diameter: Prefabricated three-piece, gasketed, flanged joint consisting of two inner ring flanges with sealant and one external closure band with gasket. Ductmate "Spiralmate" or equivalent.
      a. Prefabricated flanged joint consisting of two external flanges with sealant and gasket may be used for concealed ducts. Ductmate "Econoflange," Semco "Accuflange," or equivalent.
      b. Prefabricated self sealing gasketed coupler: Ductmate "Bullet Band".
   4. Ducts larger than 72-Inches Diameter: Companion angle flanged joints with gasket, sealed before and after fastening. Figure 3-2, Type RT-2.
      a. Prefabricated self sealing gasketed coupler: Ductmate "Bullet Band".
   5. Joints shall be made with mechanical fasteners (sheet metal screws, blind rivets, welds, bolts). Use sealer before and after fastening.
   6. Traverse Duct Joints on exposed ducts.
      a. Prefabricated self sealing gasketed coupler: Ductmate "Bullet Band".

2.9 ROUND AND FLAT OVAL DUCT FITTING FABRICATION

A. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Elgen Manufacturing
   c. McGill AirFlow Corporation.
   d. Semco Incorporated.
   e. Sheetmetal Connectors Incorporated. (www.smcduct.com)

B. General: Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standards-Metal and Flexible," Figures 3-3 through 3-5.
   1. Duct fittings shall be fabricated from metal thickness not less than required for longitudinal-seam straight duct in Tables 3-2 and 3-3.

C. Round Duct Takeoffs from Rectangular Ducts: Fabricate takeoffs with clinch-lock or spin-in conical connectors with volume dampers.
   1. Straight connectors may be used for 2-inch Duct Pressure Classification.

D. Elbows: Fabricate with welded seam, die-formed or segmented construction with bend radius 1.5 times the elbow diameter.

1. Die-Formed Elbows (8-Inches and smaller): Fabricate elbows with two-piece, die-formed construction.
2. Segmented Elbows (Larger than 8-Inches): Fabricate elbows with multiple segments or gores with number of pieces as follows:
   a. 90 degrees - 5 pieces.
   b. 60 degrees - 4 pieces.
   c. 45 degrees - 3 pieces.
   d. 30 degrees - 2 pieces.
3. 90 degrees, Two-piece Mitered Elbows: Use only where space restrictions do not permit the use of radius elbows. Fabricate elbows with single thickness turning vanes.
4. Adjustable Mitered Elbow (14-Inches and Smaller): Adjustable seam, mitered elbows (4-piece 90 degree, 3-piece 45 degree) with bend radius 0.6 times the elbow diameter may be used for 2-inch Duct Pressure Classifications. Joints shall be sealed after installation.

E. Laterals, Tees and Wyes: Fabricate with welded seam construction with conical branch taps with no excess material projecting from body into branch tap entrance.
   1. Straight branch taps may be used for 2-inch Duct Pressure Classification.
   2. Fittings with riveted or bonded joints may be used for duct diameters 16-inches and smaller for 2-inch Duct Pressure Classification. Joints shall be sealed after installation.

F. Diverging-Flow Fittings: Fabricate with welded seam with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

2.10 DUCT LINER

A. Polyester Duct Liner: Polyester fibers webbed into a thermal blanket and bonded to FSK facing. Comply with ASTM C 1071. Maximum temperature 250^{o}F (ASTM C 411); air velocity 6000 fpm (ASTM C 1071). Maximum Flame Spread Index: 25; Maximum Smoke Developed Index 50; (NFPA 255, UL 723, ASTM E 1104). Fungi and Bacteria resistant (ASTM C 665, ASTM C 1138, ASTM G 21)
   1. Manufacturers:
      a. Poly Armor: Ductmate
   2. Materials: ASTM C 1071; surfaces exposed to air stream shall be hypoallergenic FSK facing.
      a. Thickness: 1 inch.
      b. Thermal Conductivity (k-Value): 0.20 at 75 degrees F mean temperature.
      c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
      d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
      e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
         1) Tensile Strength: Indefinitely sustains a 50-lb-tensile, dead load test perpendicular to duct wall.
         2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into air stream.
         3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.
      f. Acoustic Performance: Sound absorption coefficients at octave band center frequencies. (Hz)
         1) 125Hz: 0.10; 250Hz: 0.25; 500Hz: 0.60; 1000Hz: 0.75; 2000Hz: 0.90; 4000Hz: 0.85; NRC: 0.65

2.11 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Application of Liner:
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

B. Terminate inner ducts with build-outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other build-out means are optional; when used; secure build-outs to duct walls with bolts, screws, rivets, or welds.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," and the requirements of this Section.

B. Install ducts according to SMACNA's "Rectangular Industrial Duct Construction Standards" when duct construction is outside the scope of SMACNA's "HVAC Duct Construction Standards-Metal and Flexible."

C. Construct and install each duct system according to the Duct Pressure Classification and Duct Sealing Classification indicated in previous Article "Duct Fabrication, General."

D. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

E. Install fabricated fittings for changes in directions, size, and shape and for connections.

F. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

G. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

H. Provide offset fittings where necessary to avoid structural interference's and in coordination with existing conditions and the Work of other trades.

I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Provide a minimum clearance of 1 inch, plus an allowance for insulation thickness to other elements.

J. Install ducts as high as possible, unless otherwise indicated. Where overhead structure permits, route ducts between structural elements.

K. Conceal ducts from view in finished spaces by locating within mechanical shafts, within hollow construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions unless specifically indicated.

L. Where exposed to view; install ducts as high as possible, unless otherwise indicated. Protect exposed duct from physical damage. Repair scratches, dents, cuts, and other physical imperfections. Remove stickers and markers. Prepare for field painting. Grind and polish exposed welds so no roughness shows and contours of welded surfaces match adjacent contours.

1. Supply air ducts: Provide double wall insulated duct.

M. Install insulated ducts with 1-inch clearance outside of insulation.

N. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

O. Protect duct interiors from elements and foreign materials until building is enclosed. Refer to SMACNA's "Duct Cleanliness for New Construction."

3.2 DUCT LINER APPLICATIONS

A. Apply duct liner in the following duct sections:
   1. Supply air ductwork: All rectangular supply air ductwork downstream of makeup air units discharge.
   2. Provide 1-inch thick duct liner for any duct noted on the Drawings to be lined.

3.3 WALL LOUVERS

A. Provide watertight air plenum with soldered drain pan at each louver. Connect air plenum directly to louver frame. The air plenum drain pan shall be arranged to drain to a threaded drain connection. Extend plenum drain untrapped to a floor drain.

3.4 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

B. Duct Sealing Classification: Provide SMACNA “Seal Class A” for all duct pressure classifications.
   1. Seal all transverse joints, longitudinal joints, and duct penetrations.
   2. Seal to achieve no visible or audible leaks.

C. Seal externally insulated ducts before insulation is applied.

D. Seal exposed joints internally during installation. Do not use external sealant on exposed ducts.

3.5 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs greater than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured.
   3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. For branch connections comply with SMACNA’s "HVAC Duct Construction Standards-Metal and Flexible," Figures 2-5 and 2-6.

C. For inlet and outlet connections comply with SMACNA’s "HVAC Duct Construction Standards-Metal and Flexible," Figures 2-14 and 2-15.

D. For equipment connections comply with SMACNA’s "HVAC Duct Construction Standards -Metal and Flexible," Figures 2-17.

E. Exposed galvanized ducts: Paint materials and methods are specified in Division 9 Sections.

3.7 FIELD QUALITY CONTROL

A. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports.

B. Conduct tests at static pressures equal to Duct Pressure Classification designated static pressures.

3.8 TEMPORARY USE OF AIR HANDLING SYSTEMS

A. Refer to Division 1 Section 01510 "Temporary Utilities" for additional requirements.

B. Until the permanent air handling systems are used, duct openings shall have closures to preclude the entry of construction dirt and debris into the duct system and equipment.

C. If the permanent air handling systems are used for temporary heating or ventilating prior to completion of finishing operations, the supply air systems shall be operated with 100 percent outside air (no recirculation air) with pre-filters and final filters in place and maintained.

1. Operation of air handling systems may not be possible during extreme outside air conditions.
2. The return air and exhaust air systems shall not be used. The duct openings on these systems shall have permanent closures.

D. When the building is substantially complete, the permanent air handling systems may be utilized with return air with air filters in place. Extra-ordinary measures shall be taken to prevent dirt and/or moisture from entering the duct systems.

1. Filters: Maintain clean filters in place. Install new permanent filters prior to Owner occupancy of the Project.
2. Equipment: Maintain fans and equipment until Owner occupancy of the Project.

E. Air handling system ducts shall be vacuum cleaned, and equipment surfaces washed as may be necessary to restore the systems to new condition prior to final acceptance by the Owner.

3.9 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply and exhaust fans including fan housings, plenums, scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, heat exchanger section, filters and filter sections, and drains.
4. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.

F. Cleanliness Verification:
   1. Visually inspect metal ducts for contaminants.
   2. Where contaminants are discovered, re-clean and re-inspect ducts.

END OF SECTION

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Manual volume dampers.
   2. Duct-mounted access doors.
   3. Duct accessory hardware.

B. Related Requirements:
   1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers: Maximum air velocity 3,000 fpm.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Air Balance Incorporated; a Division of Mestek, Incorporated. (www.airbalance.com)
      b. American Warming and Ventilating; a Division of Mestek, Incorporated. (www.arcat.com)
      c. Flexmaster U.S.A., Inc. (www.flexmasterusa.com)
      d. McGill AirFlow LLC. (www.mcgillairflow.com)
      e. Nailor Industries Incorporated. (www.nailor.com)
      f. Pottorff. (www.pottorff.com)
      g. Ruskin Company. (www.ruskin.com)
      h. Trox USA Incorporated. (www.troxusa.com)
      i. Vent Products Company, Incorproated. (www.ventproducts.com)
   2. Standard leakage rating, with linkage outside airstream.
   3. Maximum air velocity: 3000 fpm.
   4. Suitable for horizontal or vertical applications.
   5. Frames:

a. Frame: 5-inches wide, Hat-shaped, 0.064-inch- thick, galvanized sheet steel with reinforced corners.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:
a. Multiple or single blade.
b. 6-inches wide.
c. Parallel- or opposed-blade design.
d. Double skin air foil damper blades.
e. Galvanized-steel, 0.078 inch thick.

7. Blade Axles: ½-inch Galvanized steel.
8. Bearings:
a. Stainless steel sleeve.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axle's full length of damper blades and bearings at both ends of operating shaft.

9. Tie Bars and Brackets: Galvanized steel.

B. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 DUCT-MOUNTED ACCESS DOORS

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

1. American Warming and Ventilating; a Division of Mestek, Incorporated. (www.arcat.com)
2. Cesco Products; a Division of Mestek, Incorporated. (www.cescoproducts.com)
3. Ductmate Industries, Incorporated. (www.ductmate.com)
4. Elgen Manufacturing. (www.elgenmfg.com)
5. Flexmaster U.S.A., Incorporated. (www.flexmasterusa.com)
6. Greenheck Fan Corporation. (www.greenheck.com)
7. McGill AirFlow LLC. (www.mcgillairflow.com)
8. Nailor Industries Incorporated. (www.nailor.com)
9. Pottorff. (www.pottorff.com)
10. Ventfabrics, Incorporated. (www.ventfabrics.com)

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:
a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
a. Access Doors 12 Inches Square: No hinges and two sash locks.

2.4 DUCT ACCESSORY HARDWARE

1. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
2. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

1. Duct openings shall be free of any obstruction or irregularities that interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4" larger than damper dimensions and shall be square, straight, and level.
2. Multiple damper sections will be square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be equal ±1/8-inches.
3. Install extended shaft or jackshaft per manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
4. Damper blades, axles, and linkage shall operate without binding. Before system operation, cycle damper after installation to assure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
5. Provide a visible and accessible indication of damper position on the drive shaft end.
6. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

D. Install manual volume dampers at points on supply and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff. Install manual volume dampers as indicated on the Drawings and Details, and as necessary to accomplish system air balancing. As a minimum, manual volume dampers will be provided at every divided flow main or branch duct, at every branch duct take off, and every duct extending to individual register, grille, or diffuser.

1. Install steel volume dampers in steel ducts.
2. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. At outdoor-air intakes and mixed-air plenums.
2. Immediately upstream of control dampers.
   a. Elsewhere as indicated.
3. Install access doors with swing against duct static pressure.
4. Access Door Sizes:
   a. One or To-Hand Access: 12 by 12 inches.
5. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Install duct test holes where required for testing and balancing purposes.

END OF SECTION

SECTION 233423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate motor control requirements with building automation system installer.

PART 2 PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corporation. (www.acmefan.com)
   2. Carnes Company. (www.carnes.com)
   3. Greenheck Fan Corporation. (www.greenheck.com)
   4. Loren Cook Company. (www.lorencook.com)

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
   2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Direct Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Fan motor isolated from exhaust airstream.

E. Accessories:
   1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Self-flashing without a cant strip, with mounting flange.
   2. Overall Height: 12 inches.

G. Capacities and Characteristics:
   1. Refer to fan schedule on the drawing for capacities and characteristics.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Explosion Proof.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Install power ventilator accessories.

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Verify lubrication for bearings and other moving parts.
   5. Verify that manual and automatic volume control dampers in connected ductwork systems are in fully open position.
   6. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   7. Shut unit down and reconnect automatic temperature-control operators.
   8. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

E. Submit startup reports.

3.4 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

B. Lubricate bearings.

END OF SECTION

SECTION 233516
VEHICLE ENGINE EXHAUST SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Vehicle Engine Exhaust Systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Roof curbs.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hose reels and fans to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal for performance, sound and fabrication.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.6 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate motor control requirements with building automation system installer.

PART 2 PRODUCTS

2.1 EXHAUST SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Car-Mon Products
   2. Engwald Corp.
   3. Monoxivent

B. Hose Reels: Power operated manually controlled hose reel consisting of welded steel frame using tubular steel and 12 gauge end plates, airtight rotating cylinder with recessed inlet fitting for flange mounting flexible hose, Reel drive with direct drive coupling system, Hose reel gear motor with limit switch and reversing IEC contactor, 25 feet of 7 inch diameter flexible exhaust hose, Tail pipe adapter, hose limit stops, Integral direct drive centrifugal exhaust fan, and Remote hanging 4 push button pendant control station. (Car-Mon Series TSR-P)

1. Frame: 2x2x1/8 inch tubular steel.
2. Reel motor: 1/3 HP, 115v, 1 phase, 60 Hz, explosion proof, reversible gear motor.
3. Hose: Fire retardant, anti-static, heat resistant, high tensile strength weave fabric, triple overlap two-ply construction with spring steel reinforcing spiral, process saturated with polymeric resins and heat cured to withstand temperatures to 1500 deg. F continuous. (Car-Mon ZYK)
4. Hose connection: Bolted and Gasket seal connection between hose and reel.
5. Centrifugal Exhaust Fan: 3 HP, 208v, 3 phase, 60 Hz, explosion proof motor, Radial blade type fan wheel statically and dynamically balanced. Minimum 10 gauge all welded steel fan housing. Fan inlet bolted to hose reel outlet. (Car-Mon DXi-12A0)
6. Flexible Connectors: UL 214 listed, Fire retardant, polyethylene impregnated fabric, minimum density 36 oz. per sq. yd., approximately 3 inch wide crimped metal edging strip, rated to withstand temperatures to 700 deg. F.
7. Control chord drop from hose reel with push button control station at bottom of chord for control of reel unwind and wind and fan on/off. Length of chord to locate push button station 5 ft. above finish floor.
8. Electrical: Single point power connection. Integral relays, starters and transformers.
9. All explosion resistant construction.
10. Reel housing and Fan Finish: Polyester powder coat finish.

C. Ductwork: Fabricate and support ductwork in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible Round Industrial Duct Construction Standard and Rectangular Industrial Duct Construction standard and ACGIH Industrial Ventilation Manual except as indicated.

1. Construct exhaust duct to static pressure classification equal to highest static pressure associated fan can produce at highest fan speed and choked flow. Minimum 10 in.wg. whichever is greatest.
2. Exhaust duct to be all welded construction with welds ground smooth.
3. Duct material: Type 316 stainless steel.

D. Accessories:

1. Tail Pipe Adapters: Minimum 20 gauge, ASTM A167 stainless steel conical adapter complete with chain and hook assembly. (Car-Mon CTA-7)
2. Provide custom adapter capable of enclosing Mack Truck exhaust pipe shown on drawings.
3. Provide quick disconnect at hose for easy changing of adapters.
4. Diesel Cane Adapter for high exhaust connection on diesel engines. (Car-Mon DCA-8)

E. Duct Penetration Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 12 inches.

F. Capacities and Characteristics:

1. Refer to fan schedule on the drawing for capacities and characteristics.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Explosion Proof.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install hose reels in accordance with manufacturer's instructions level and plumb.

B. Install hose reel accessories.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of hose reels, ductwork and accessories. Make duct connections to exhaust fan discharge with flexible connectors.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Verify lubrication for bearings and other moving parts.
5. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
6. Shut unit down and reconnect automatic temperature-control operators.
7. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

E. Submit startup reports.

3.4 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

B. Lubricate bearings.

END OF SECTION

SECTION 233713
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Drum louvers.

B. Related Sections:
   1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Section 233300 "Air Duct Accessories" for manual balancing dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, mounting surface, border, frame, and accessories furnished.

1.4 COORDINATION

A. Review the architectural drawings for diffuser, register, and grille mounting surfaces.

PART 2 - PRODUCTS

2.1 HIGH-CAPACITY DIFFUSERS

A. Drum Louver:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Carnes.
      c. METALAIRE, Inc.
      d. Nailor Industries Inc.
      e. Price Industries.
      f. Titus.
   2. Airflow Principle: Extended distance for high airflow rates.
   3. Material: Aluminum, heavy gage extruded.
   4. Finish: Clear aluminum mill finish.
   5. Border: 1-1/4-inch width with countersunk screw holes.
   6. Gasket between drum and border.
   7. Body: Drum shaped; adjustable vertically.
   8. Blades: Individually adjustable horizontally.
   9. Mounting: Surface to duct.
   10. Inlet Width: 6 inches.
   11. Inlet Length: 18 inches.
   12. Accessories:
      a. Duct-mounting collars with countersunk screw holes.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

C. Provide the appropriate mounting frame or border for each diffuser register or grille location. Non-lay-in diffusers, registers, and grilles will have frames or borders for surface mounting.

3.2 INSTALLATION

A. Diffuser, register, and grille sizes and locations are indicated on the drawings and schedules.

B. Install diffusers, registers, and grilles level and plumb.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 233723
HVAC GRAVITY VENTILATORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Roof hoods.

1.3 PERFORMANCE REQUIREMENTS

A. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 SUBMITTALS

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

B. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members to which roof curbs and ventilators will be attached.
   2. Sizes and locations of roof openings.

1.5 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 PRODUCTS

2.1 MATERIALS

A. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.

B. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

2.2 ROOF HOODS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Mfg. Corporation. (www.acmefan.com)
   2. Aerovent. (www.aerovent.com)
   3. Greenheck Fan Corporation. (www.geenheck.com)
   4. JencoFan. (www.jencofan.com)
   5. Loren Cook Company. (www.lorencook.com)
   6. PennBarry. (www.pennbarry.com)

B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.

C. Materials: Galvanized-steel sheet, minimum 0.064-inch-thick base and 0.040-inch-thick hood, suitably reinforced.

D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
   1. Configuration: built-in cant and mounting flange.
   2. Overall Height: 18 inches.

E. Bird Screening: Galvanized-steel, ½-inch-square mesh, 0.041-inch wire.

F. Galvanized-Steel Sheet Finish:
   1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

G. Capacities and Characteristics: Refer to drawings and equipment schedules.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible. Refer to Division 07 Section "Roof Accessories."

C. Install gravity ventilators with clearances for service and maintenance.

D. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

END OF SECTION

SECTION 237333
INDOOR, INDIRECT, GAS-FIRED HEATING AND VENTILATING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged indirect, gas-fired heating and ventilating units.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and configuration of indoor, indirect, gas-fired heating and ventilating unit.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type and configuration of indoor, indirect, gas-fired heating and ventilating unit.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
   4. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Startup service reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect-fired heating and ventilating units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set for each unit.
   2. Fan Belts: One set for each unit.

1.8 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of indirect, gas-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Greenheck Fan Corporation.
2. Hastings HVAC; Division of Eric, Inc.
3. Modine Manufacturing Company.
4. Reznor/Thomas & Betts.
5. Sterling HVAC Products.
6. Trane.

2.2 SYSTEM DESCRIPTION

A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, damper, controls, filters, and indirect-fired gas burner to be installed inside the building.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
3. Factory Finish for Galvanized-Steel Casings: Immediately after cleaning and pre-treating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
4. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Configuration: Horizontal unit with horizontal front discharge and back inlet for floor mounted installation.

C. Cabinet: Aluminized- or galvanized-steel panels formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Duct flanges at inlet and outlet.

D. Outer Casing: 0.0478-inch-thick steel with heat-resistant, baked-enamel finish over corrosion-resistant-treated surface in color to match fan section.

E. Inner Casing:

1. Burner Section Inner Casing: 0.0299-inch steel.
2. Double-wall casing with inner wall of perforated steel, for the following sections:
   a. Blower section.
   b. Filter section.
   c. Inlet plenum.
   d. Discharge plenum.
   e. Access Doors: Hinged with handles for burner and fan motor assemblies on both sides of unit.
3. Internal Insulation: Fibrous-glass duct lining, neoprene coated, comply with ASTM C 1071, applied on complete unit.
   a. Thickness: 1 inch.
   b. Insulation Adhesive: Comply with ASTM C 916.

c. Density: 1.5 lb/cu. ft.
d. Mechanical Fasteners: Galvanized steel suitable for adhesive, mechanical, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.

F. Casing Internal Insulation and Adhesive:
1. Materials: ASTM C 1071.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the heating-coil section.
a. Liner Adhesive: Comply with ASTM C 916.
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive, mechanical, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service-air velocity.
3. Location and Application: Encased between outside and inside casing.

G. Inspection and Access Panels and Access Doors:
1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:
a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
b. Gasket: Neoprene, applied around entire perimeters of panel frames.
c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
3. Access Doors:
a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
b. Gasket: Neoprene, applied around entire perimeters of panel frames.
4. Locations and Applications:
a. Fan Section: Doors.
b. Access Section: Doors.
c. Filter Section: Doors large enough to allow periodic removal and installation of filters.

2.4 SUPPLY-AIR FAN

A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, self-aligning, permanently lubricated ball bearings rated for L50 or 200,000 hours with external grease fittings.

B. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.

C. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained spring isolators.

D. Fan-Shaft Lubrication Lines: Extended to a location outside the casing.

2.5 AIR FILTERS

A. Comply with NFPA 90A.

B. Disposable Filters: Factory-fabricated, pleated-type, disposable air filters with holding frames with MERV 8 rating according to ASHRAE 52.2.
1. Thickness: 2 inches.
2. Media: Interlaced polyester fibers.
3. Frame: Galvanized steel.
4. Maximum Face Velocity: 500 fpm.

2.6 DAMPERS

A. Outdoor-Air Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. of damper area, at a differential pressure of 2-inch wg.

B. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.

2.7 INDIRECT-FIRED GAS BURNER

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and with NFPA 54, "National Fuel Gas Code."
   1. CSA Approval: Designed and certified by and bearing label of CSA.
   2. Burners: Stainless steel.
      a. Gas Control Valve: Modulating.
      b. Fuel: Natural gas.
      c. Minimum Combustion Efficiency: 80 percent.
      d. Ignition: Electronically controlled electric spark with flame sensor.

B. Venting: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.

C. Combustion-Air Intake and Vent Assembly: Manufacturers concentric combustion-air intake and vent terminal assembly kit.

D. Heat Exchanger: Stainless steel.

E. Heat-Exchanger Drain Pan: Stainless steel.

F. Safety Controls:
   1. Vent Flow Verification: Differential pressure switch to verify open vent.
   2. Control Transformer: 24-V ac.
   3. High Limit: Thermal switch or fuse to stop burner.
   4. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
   5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
   6. Gas Manifold: Safety switches and controls complying with ANSI standards FM Global.
   7. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
   8. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
   9. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.8 UNIT CONTROL PANEL

A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

B. Control Panel: Surface-mounted**,** remote panel, with engraved plastic cover, and the following lights and switches:
   1. On-off-auto fan switch.
   2. Heat-vent-off switch.
   3. Supply-fan operation indicating light.
   4. Heating operation indicating light.
   5. Thermostat.
   6. Damper position potentiometer.
   7. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
   8. Safety-lockout indicating light.
   9. Enclosure: NEMA 250, Explosion proof.

2.9 CONTROLS

A. Comply with requirements in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls" for control equipment and sequence of operation.

B. Control Devices:

1. Remote Thermostat: Adjustable room thermostat with temperature readout.
2. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.
3. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature.
4. Ionization-Type Smoke Detectors: 24-V dc, nominal; self-restoring; plug-in arrangement; integral visual-indicating light; sensitivity that can be tested and adjusted in place after installation; integral addressable module; remote controllability; responsive to both visible and invisible products of combustion; self-compensating for changes in environmental conditions.
5. Smoke detectors, located in supply air, shall stop fans when the presence of smoke is detected.

C. Fan Control: Provide variable frequency drive controller to vary fan speed from external BAS 0-10vdc or 4 – 20ma signal. Interlock fan to start with BAS programmed start/stop.

D. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.

E. Temperature Control: Operates gas valve.

1. Operates gas valve to maintain space temperature with wall-mounted, field-wired sensor with temperature adjustment on remote-control panel.
2. Burner Control: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display status and alarms of heating and ventilating unit.

1. Hardwired Points:
   a. Room temperature.
   b. Discharge-air temperature.
   c. Burner operating.
   d. Supply fan CFM.
2. Johnson Controls N2 compatible communication interface with the BAS shall enable the BAS operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the BAS.

2.10 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motors to be inverter duty rated, totally enclosed, fan cooled.

2.11 CAPACITIES AND CHARACTERISTICS

A. Refer to equipment schedule for capacity and characteristics.

B. Single point electrical power connection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of indirect-fired heating and ventilating units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Install heating and ventilating units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Unit Support: Install heating and ventilating unit level on structural concrete slabs. Coordinate wall penetrations and flashing with wall construction.

C. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

D. Install controls and equipment shipped by manufacturer for field installation with indirect-fired heating and ventilating units.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless-steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Drain: Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers.

C. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections [with the assistance of a factory-authorized service representative].

C. Units will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. [Engage a factory-authorized service representative to perform] [Perform] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
2. Inspect for visible damage to burner combustion chamber.
3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that clearances have been provided for servicing.
5. Verify that controls are connected and operable.
   a. Verify that filters are installed.

b. Purge gas line.
c. Inspect and adjust vibration isolators.
d. Verify bearing lubrication.
e. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
f. Adjust fan belts to proper alignment and tension.
g. Start unit according to manufacturer's written instructions.

6. Complete startup sheets and attach copy with Contractor's startup report.
7. Inspect and record performance of interlocks and protective devices; verify sequences.
8. Operate unit for run-in period recommended by manufacturer.
9. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
   a. Measure gas pressure at manifold.
   b. Measure combustion-air temperature at inlet to combustion chamber.
   c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
10. Calibrate thermostats.
11. Adjust and inspect high-temperature limits.
12. Inspect inlet damper for proper stroke.
13. Inspect controls for correct sequencing of heating, fan speed and emergency shutdown.
14. Measure and record airflow. Plot fan volumes on fan curve.
15. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:
    a. High-limit heat.
    b. Alarms.
16. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
17. Verify drain-pan performance.
18. Verify outdoor-air damper operation.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION

SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
2. Common electrical installation requirements.
3. Demolition.
4. Cutting and patching for electrical construction.
5. Touchup painting.
6. Disposition of existing materials and equipment.
7. Electric Service Outage and Energizations.

1.3 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. Comply with State and City Code requirements.

D. All materials shall meet the standards of the following institutes where applicable:

1. National Fire Protection Association (NFPA)
2. American Society of Testing Materials (ASTM)
3. American National Standards Institute (ANSI)
4. National electrical Manufacturer's Association (NEMA)
5. Institute of Electrical and Electronic Engineers (IEEE)

1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 083100 "Access Doors and Panels."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 078400 "Firestopping."

E. 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.

F. 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.

G. Coordinate electrical service connections to components furnished by utility companies.
   1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

H. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability. Document results of said testing.

1.5 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness. All devices, raceway, and electrical equipment in finished and/or public spaces shall be recessed or concealed unless otherwise noted.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans.

C. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.6 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service.

B. Drawings indicate design loads, voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the owner. Such adjustment shall be subject to the review of the Architect.

C. Incidental items not indicated on Drawing or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide complete system, shall be furnished and installed though not itemized here in detail.

1.7 MECHANICAL SYSTEMS INTERFACE

A. All control wiring for plumbing, heating, ventilating and air conditioning systems shall be installed under Division 23. Review Division 23 specifications and shop drawings for control systems to assure compatibility between equipment furnished under Division 23 and wiring furnished under Division 26.

B. Motor controllers (starters) shall be furnished and installed under Division 26, unless specified to be furnished as an integral component of the equipment. Provide the number and type of auxiliary contacts necessary to interlock the equipment and provide the specified control sequence.

1.8 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions which are not detailed on the drawings must still be restored to their original condition.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.0 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.1 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078400 "Firestopping."

3.2 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Reroute circuits as required to serve equipment not in the demolition area.

C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

D. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

E. Remove demolished material from Project site.

F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.

H. Assume that all existing equipment and fixtures indicated to be reused are in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair

or in unusable condition for direction or decision. Repair any damage to equipment caused in removal or handling

I. Fixtures and other equipment removed and to be-used shall be cleaned before reinstallation. Provide new lamps for reused light fixtures.

J. Added Circuits: All loads and circuits added to existing panelboards shall be balanced between phases. On existing panelboards where circuits are changed, replace panel directories with new typed directories.

K. All material and equipment which is noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the owner and stored where directed on the site.

L. Remove all abandoned low voltage wiring. All wiring disconnected on one or both ends is considered abandoned unless tagged and labeled “future” or “spare”. Verify with Owner any cabling connected on both ends is still in use prior to removal.

3.3 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.4 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Firestopping.
2. Electrical demolition.
3. Cutting and patching for electrical construction.
4. Touchup painting.

3.5 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 099000"Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.7 DISPOSITION OF EXISTING BALLASTS CONTAINING PCBS

A. Environmental Protection Agency (EPA) Regulations [and Minnesota Pollution Control Agency (MPCA) Rules] require controlled disposal of fluorescent light ballasts containing polychlorinated biphenyls (PCBs) when removed from service. The ballasts involved were generally manufactured between 1950 and 1979.

B. Provide suitable ballast collection containers at the project site. Check the ballasts in all fluorescent fixtures removed from service under this contract. Some ballasts may be labeled to indicate whether they do or do not contain PCBs. Remove from the fixtures all ballasts known or assumed to contain PCBs and place them in the designated ballast collection container and arrange for the disposal of the ballasts off the site in manner approved by the EPA [and MPCA].

C. Bear all cost for ballast recycling.

3.8 DISPOSITION OF EXISTING FLUORESCENT LAMPS

A. EPA Regulations [and Minnesota Pollution Control Agency (MPCA) rules] require the controlled disposal of fluorescent lamps.

B. Remove all existing fluorescent lamps and package to prevent breakage according to EPA Regulations. Ship the lamps to a licensed lamp recycling facility with an approved material handler.

C. Furnish the Owner with a Certificate of Disposal for these lamps, indicating the number of lamps, time and location of disposal.

D. Bear all cost for lamp recycling.

3.9 ELECTRIC SERVICE OUTAGE AND ENERGIZATIONS

A. Owner Approval: Electric service outages or energizations required shall be approved by the Owner before outages or energization. Outages shall be scheduled at the convenience of the Owner.

B. Written Request: Requests for outages and energizations shall be submitted in writing to the Owner for approval at the earliest possible date and in no case later than 14 days prior to the outage and/or energization.

C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours notice has been given by the Owner.

D. Schedules: A minimum of two (2) weeks before the first outage, submit a schedule of proposed sequence of all the electric feeder and switchboard outages and energizations. This schedule shall show construction energizations and shall include any weekend work. The schedule shall list the work to be completed during and between each outage.

E. Minimize all outages on the Owner's electrical system and employ sufficient workmen so that work will be carried on concurrently at more than one location, when necessary.

F. Before submitting any energization and/or outage requests, provide the owner with evidence that the following requirements have been met:

1. All required equipment and material is on the job site. All related installations that can be worked on without an energization and/or outage are complete, tested, available for inspection, and ready for service.
2. All shop drawings, test reports, installation data, and operational data have been submitted and approved.
3. The energizing and outage schedule has been submitted and approved.

G. Similar outage procedures shall be followed for telecommunications and other services to the facility.

3.10 PRIMARY SERVICE PROCEDURES

A. During the energization and/or outage follow established switching procedures. Coordinate with the Owners operating personnel.

B. Service disconnecting means and primary switches shall be left open and tagged in the name of a person to be designated by the Owner. In no case shall these cards be removed or switches closed without that person's approval.

C. Operation of each primary switch installed under the contract shall be under Division 26. All switching of Owner system to perform the outage shall be performed by Division 26.

D. At the time of energizing each primary feeder and/or equipment, the Contractor will be prepared to handle any situation that may arise from a cable or equipment failure or other faults on the system. If a failure or a fault occur, check out and place the system in proper operation with the required personnel and equipment.

E. All primary and secondary temporary connections will be performed under Division 26.

END OF SECTION

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:
   1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.

1.2 DEFINITIONS

A. VFC: Variable frequency controller.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. Alpha Wire.
   3. Belden Inc.
   4. Encore Wire Corporation.
   5. General Cable Technologies Corporation.
   6. Southwire Incorporated.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2.

D. Fire Rated Cable and Assemblies:
   1. TYCO MI 2 Hour Rated Cable
      a. Prysmian Group/Drakausa Lifeline or approved equal 2 hour fire rated cable for installation in rigid steel conduit or EMT. Conductor size: 14 AWG – 750 kcmil single conductors. Co-ordinate with Section 260533 “Raceways and Boxes for Electrical Systems” for installation requirements.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Gardner Bender.
   3. Hubbell Power Systems, Inc.
   4. Ideal Industries, Inc.
   5. Ilsco; a branch of Bardes Corporation.
   6. NSi Industries LLC.
   7. O-Z/Gedney; a brand of the EGS Electrical Group.
   8. 3M; Electrical Markets Division.
   9. Tyco Electronics.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded.

B. Branch Circuits: Strnaded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2 single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2 single conductors in raceway.

E. Exposed Branch Circuits: Type THHN-2 single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2 single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2 single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16. Service entrance conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.310.7.

D. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.

E. Underground electrical duct ampacity rating shall be in accordance with NEC Table B.310.7 or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.

F. Record drawing shall include the calculations and sketches.

G. 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.

H. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

I. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

J. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

K. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings. Where the quantity of wires is not indicated on the drawings for branch circuits (2) #12 copper conductors shall be provided.

L. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings. The minimum size of emergency systems conductors shall be No. 10 AWG. 60 deg. C ampacities shall be used for sizing all wire and cable for feeders rated 100 amps and below. 75 deg. C ampacities shall be used for sizing of all wire and cable for feeders rated over 100 amps. This sizing requirement applies to all cables in these size ranges, including those with higher insulation ratings. Use No. 10 AWG for conductors in 120 volt 20 amp branch circuits longer than 100 feet (80 m), and in 277 volt 20 amp branch circuits longer than 200 feet (160 m).

3.4 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Pulling shall be continuous without unnecessary stops and starts with wire or cable onlypartially thru raceway.

D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.

E. Cables or wires shall not be laid out on the ground before pulling.

F. Cables or wires shall not be dragged over earth or paving.

G. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.

H. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.

I. Only nylon rope shall be permitted to pull cables into conduit and ducts.

J. At least six (6) inch loops or ends shall be left at each outlet for installation connection of fixtures or other devices.

K. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

L. Completely and thoroughly swab raceway system before installing conductors.

3.5 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage.

B. Use suitable cable fittings and connectors.

C. Run all open cable in a neat and symmetrical manner. Follow the routing as illustrated on the drawings as closely as possible. If routing is not illustrated then the Contractor shall choose his own routing, but in any case it shall be run in a manner previously stated.

D. Open cable shall be supported by the appropriate size bridle rings or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same bridle rings.

E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.

F. Where open cables are grouped, they shall be neatly bundled and held together with nylon tie wraps placed every 2.5 ft. on the bundle. Where tie bundle passes through a bridle ring it shall be fastened to the ring with a tie wrap.

G. Bridle ring supports shall be installed at five foot (5') intervals. All rings shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc.

H. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

3.6 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.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Splice and tap only in accessible junction boxes.

E. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for copper conductor terminations, 8 AWG and larger.

F. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.

G. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.

H. Use copper, compression connectors applied with circumferential crimp for copper wire splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

I. Thoroughly clean wires before installing lugs and connectors.

J. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

K. Terminate spare conductors with electrical tape, unless otherwise indicated on the drawings.

L. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.

M. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus: Facing the front and operating side of the equipment, the phase identification shall be:

1. Left to Right - A-B-C
2. Top to Bottom - A-B-C

N. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.7 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

3.8 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.9 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
      a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test and Inspection Reports: Prepare a written report to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Cables will be considered defective if they do not pass tests and inspections.

3.11 WIRE AND CABLE INSTALLATION SCHEDULE

A. Concealed Interior Locations: Building wire in raceways.

B. Exposed Interior Locations: Building wire in raceways.

C. Above Accessible Ceilings: Low voltage (less than 110 volts) shall be installed without conduit unless otherwise noted.

D. Wet or Damp Interior Locations: Building wire in raceway.

E. Exterior Locations: Building wire in raceways.

F. Underground Locations: Building wire in raceways.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

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

B. Section includes grounding and bonding systems and equipment.

C. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Overhead-line grounding.
2. Underground distribution grounding.
3. Ground bonding common with lightning protection system.
4. Foundation steel electrodes.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. <Insert items>.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

D. Refer to Section 018113 Sustainable Design Requirements for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Instructions for periodic testing and inspection of grounding features at [test wells] [ground rings] [grounding connections for separately derived systems] <Insert locations> based on [NETA MTS] [NFPA 70B] <Insert reference>.
      1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      2) Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; A Brand of the EGS Electrical Group.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.
11. <Insert manufacturer's name>.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: [Copper] [or] [tinned-copper] wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, [1/4 by 4 inches (6.3 by 100 mm)] <Insert dimensions> in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless [compression] [exothermic]-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: [Copper-clad] [Zinc-coated] [Stainless] steel[, sectional type]; [3/4 inch by 10 feet (19 mm by 3 m)] [5/8 by 96 inches (16 by 2400 mm)].

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with [non-hazardous electrolytic chemical salts] <Insert enhancement material>.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for [No. 8] <Insert number> AWG and smaller, and stranded conductors for [No. 6] <Insert number> AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare [tinned-]copper conductor, [No. 2/0] <Insert number> AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING OVERHEAD LINES

A. Comply with IEEE C2 grounding requirements.

B. Install [two] <Insert number> parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.

C. Drive ground rods until tops are 12 inches (300 mm) below finished grade in undisturbed earth.

D. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.

E. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.

F. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.

G. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

3.3 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.4 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.5 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.6 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

H. Metallic Fences: Comply with requirements of IEEE C2.
   1. Grounding Conductor: Bare[, tinned] copper, not less than [No. 8] <Insert number> AWG.
   2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
   3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.7 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. For grounding electrode system, install at least [three] <Insert number> rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
   1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [tinned]bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each [steel column] [indicated item], extending around the perimeter of [building] [area or item indicated].
   1. Install tinned-copper conductor not less than [No. 2/0] <Insert number> AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than [24 inches (600 mm)] <Insert dimension> from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of [20 feet (6 m)] <Insert dimension> of bare copper conductor not smaller than [No. 4] <Insert number> AWG.
   1. If concrete foundation is less than [20 feet (6 m)] <Insert dimension> long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[, at ground test wells][, and at individual ground rods]. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: [10] <Insert value> ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: [5] <Insert value> ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: [3] <Insert value> ohms.
   4. Power Distribution Units or Panelboards Serving Electronic Equipment: [1] [3] <Insert value> ohm(s).
   5. Substations and Pad-Mounted Equipment: [5] <Insert value> ohms.
   6. Manhole Grounds: [10] <Insert value> ohms.
   7. <Insert application and maximum ground-resistance value> ohms.

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

I. Provide receptacle testing per NFPA 99. Provide documentation of results.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.4 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. Hilti
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Bolt to concrete inserts.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
4. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
5. To Light Steel: Sheet metal screws.
6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

1. Concrete bases shall be installed at floor mounted transformers, switchboards, automatic transfer switches, floor mounted distribution panels and power conditioners.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Surface raceways.
   5. Boxes, enclosures, and cabinets.

B. Related Requirements:
   1. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.2 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

C. Fittings: Conduit connection or coupling.

D. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.

E. 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.

F. 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/or floors.

G. 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.

H. 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.

I. Slab: Horizontal pour of concrete used for the purpose of a floor or sub-floor.

PART 2 PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Steelduct
   2. Allied Tube & Conduit; a Tyco International Ltd. Co.
   3. LTV
   4. O-Z/Gedney; a brand of EGS Electrical Group.
   5. Wheatland Tube Company; a division of John Maneely Company.
   6. Appleton Electric
   7. Midwest
   8. Thomas & Betts

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel.

1. Minimum 3/4 inch galvanized steel, unless noted otherwise. Lighting branch circuit wiring to an individual luminaire may be a manufactured UL listed 3/8" flexible metal conduit with #12 AWG THHN conductors and an insulated ground wire.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. Minimum Size Metallic Conduit: ¾ inch, unless otherwise noted.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:
   a. Material: Steel.
   b. Type: compression.
   c. 2" Diameter or Smaller: Compression or steel set screw type of steel designed for their specific application.
   d. Larger than 2": Compression or steel set screw type of steel designed for their specific application.

2. Fittings for GRC and IMC:
   a. Material: Galvanized Steel.
   b. Expansion Fittings: Steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
   c. GRC/IMC - End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
   d. GRC/IMC - Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
   e. GRC/IMC - Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
   f. GRC/IMC - Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
   g. GRC/IMC - All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

3. Fittings for FMC:
   a. Material: Galvanized Zinc Steel.
   b. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
   c. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.

4. Fittings for LFMC:
   a. Material: Galvanized Zinc Steel and factory formed PVC cover.
   b. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, with PVC coating, UL listed.
   c. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.

J. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

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

1. CANTEX Inc.
2. Lamson & Sessions; Carlon Electrical Products.
3. J.M. Manufacturing
4. Chevron Phillips
5. ARCON

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC and EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
1. Minimum size: ¾ inch, unless otherwise noted.
2. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
3. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

E. LFNC: Comply with UL 1660.

F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

G. Fittings for LFNC: Comply with UL 514B.

H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.
3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard prime coating, ready for field painting as indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Mono-Systems, Inc.
b. Panduit Corp.
c. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
   4. Erickson Electrical Equipment Company.
   5. FSR Inc.
   6. Hoffman; a Pentair company.
   7. Hubbell Incorporated; Killark Division.
   8. Kraloy.
   9. Milbank Manufacturing Co.
   10. Mono-Systems, Inc.
   11. O-Z/Gedney; a brand of EGS Electrical Group.
   12. RACO; a Hubbell Company.
   13. Robroy Industries.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
   16. Thomas & Betts Corporation.
   17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Metal Floor Boxes:
   1. Material: Cast metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

J. Gangable boxes are allowed where approved by code.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:
   1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

2.6 ACCESSORIES

A. Noise Control, and Fire Rated Moldable Pads: UL #970, moldable sheet putty at required thickness on all five sides of back boxes.
   1. Kinetics Noise Control – Iso Backer Pad
   2. SpecSeal – SSP Putty and Pads
   3. 3M #MPP-4S

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC, IMC.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased. As indicated.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC, IMC. Raceway locations include the following:
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: GRC.
   7. Boxes and Enclosures: NEMA 250, Type 1.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Threadless fittings with set screws.

E. Conduit color specifics per system designation:
   1. Normal Power – Green
   2. Normal Power Lighting – Orange
   3. Emergency Power – White
   4. Telecommunications – Blue
   5. Control Wiring – Black
   6. Fire Alarm System – Red
   7. Security Systems – Yellow
   8. Nurse Call Systems - Purple

3.2 CONDUIT SIZING

A. Size conduit as shown on the drawings and specifications. Where not indicated, conduit size shall be according to NEC (Latest Adopted Edition). Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the National Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.

B. Minimum Conduit Size (Unless Noted Otherwise):
   1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
   2. Below Grade 5' or less from Building Foundation: 1 inch.
   3. Below Grade More than 5' from Building Foundation: 1 inch.
   4. Telecommunication Conduit: 3/4 inch.

C. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.3 CONDUIT ARRANGEMENT

A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.

B. Conduit shall not share the same cell as structural reinforcement in masonry walls.

C. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.

D. Contractor shall adapt his work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.

E. Contractor shall cooperate with all Contractors on the project. He shall obtain details of other Contractor's work in order to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by him. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.4 CONDUIT SUPPORT

A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other nonstructural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.

D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1-1/2" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.

F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.

G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2’-0” on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2’-0” spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the National Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.

K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the National Electrical Code requirements.

L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.

M. Finish:

1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1” of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6’-6” of finish floor and presents potential injury to personnel.

3.5 CONDUIT INSTALLATION

A. Conduit Connections:

1. Shorter and standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will <u>not</u> be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2” in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
2. All bends of rigid non-metallic conduit (RNC) shall be made with the manufacturer’s approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360 degrees), including those bends located immediately at the outlet or body.
4. Galvanized Rigid Conduit (GRC) runs longer than 100 feet or runs which have more than two 90 degree equivalent bends (regardless of length) shall use rigid steel factory elbows for bends.
5. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the National Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.

4. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
5. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer's recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal.
6. Contractor shall be responsible for all openings required in masonry or exterior walls under this division. a qualified mason at the expense of this contractor shall repair all openings to match existing conditions.
7. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20 degrees F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, equal to O-Z/Gedney type EYD.
8. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.
9. Do not route conduits across each other in slabs on grade.
10. Rigid non-metallic conduit (RNC) shall be installed when surface temperatures are greater than 40 degrees F.
11. Where rigid non-metallic conduit (RNC) conduit is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
12. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
13. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.
14. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4” above finished floor (AFF) and as close to the wall as possible.

3.6 CONDUIT TERMINATIONS

A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, or approved equivalent.

B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.

C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.

D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the National Electrical Code, shall be connected using flexible conduit rated for the environment.

F. Rigid non-metallic conduit (RNC) conduit shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer’s recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.

G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of any and all foreign matter prior to any wires or pull cords being installed.

3.7 UNDERGROUND CONDUIT INSTALLATION

A. Conduit Connections:
   1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

B. Conduit Bends (Lateral):
   1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
   2. All Telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault (handholes and manholes) with “JackMoon” or equivalent duct seal, capable of withstanding a 10 foot head of water (5 PSI).

C. Conduit Elbows (Vertical):
   1. Minimum steel elbow radii shall be 30 inches for primary conduits (>600V) and 18 inches for secondary conduits (<600V). Increase radius, as required, based upon pulling tension calculation requirements.

D. Conduit Placement:
   1. Conduit runs shall be pitched a minimum of 4” per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
   2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
   3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum f'c = 2500 and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
   4. Before the Contractor pulls any cables into the conduit he shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
   5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
   6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
   7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
   8. All non-metallic conduit installed underground outside of a slab shall be rigid.

E. Horizontal Directional Boring:
   1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
   2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

3.8 CONDUIT INSTALLATION SCHEDULE

A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If This Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the National Electrical Code shall be required.

B. The following schedule shall be adhered to unless they constitute a violation of applicable codes or are noted otherwise on the drawings. The installation of GRC conduit will be permitted in place of any and all conduit specified in this schedule.
   1. Dry Mechanical Spaces:
      a. Exposed:

1) Switchboards, panel feeders, etc: EMT.
2) Branch Circuits (lighting, receptacles, controls, etc.): EMT.
3) Mechanical Equipment Feeders (pumps, AHU's, chillers, etc.): EMT
4) Floor Mounted Pump Feeders: EMT with no more than 6' of supported PVC coated flexible metal conduit to pump.

b. Concealed: EMT

2. Wet or Damp Locations: GRC conduit.
3. Finished Spaces: Concealed EMT.
4. In or Under Slabs on Grade or Site Conduits:
   a. Within 5' from the Perimeter of a Building Foundation: Concrete encased RNC conduit with a minimum of 3" thickness between the surface of the concrete and the nearest conduit. Concrete to be doweled into the foundation.
   b. 5' or Greater from the Perimeter of a Building Foundation: RNC.
   c. Under Roads, Drives, and Vehicle Traveled Ways: Concrete Encased RNC: On all sides with not less than 3" of concrete.
5. Interior Locations:
   a. Exposed: RMC conduit.
   b. Concealed: EMT.
6. Hazardous Locations as Defined by the National Electrical Code: PVC coated GRC conduit complete with screwed fittings and conduit seals.

3.9 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:
   1. Concealed interior locations above ceiling and in hollow studded partitions.
   2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8'-0" above the highest platform level.
   3. Direct contact with concrete except slab on grade.
   4. Recessed in stud wall of kitchens and laundries.

B. Cast boxes shall be used in:
   1. Exterior locations.
   2. Hazardous locations.
   3. Exposed interior locations within 8' of the highest platform level.
   4. Direct contact with earth.
   5. Direct contact with concrete in slab on grade.

3.10 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with Architect and General Contractor.

C. Locate and install to maintain headroom and to present a neat appearance.

D. Coordinate locations with Mechanical Contractor to avoid perimeter heating equipment enclosures.

3.11 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Do not install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

F. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

G. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

H. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

I. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

J. Expansion-Joint Fittings:
   1. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
      b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
      c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
   3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
   4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

K. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC in damp or wet locations not subject to severe physical damage.

L. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

M. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

N. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

O. Locate boxes so that cover or plate will not span different building finishes. Do not install boxes back-to-back. Provide minimum horizontal offset of 24 inches between boxes installed on opposite sides of stud walls.

1. Where the minimum 24-inch horizontal separation cannot be maintained in fire-rated walls, installed fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
2. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies and where minimum 24-inch horizontal separation cannot be maintained in non-fire rated walls. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

P. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Q. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

R. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

S. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

T. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

U. Set outlet boxes for flush mounted devices to within 1/8” of finished wall.

V. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8” of finished wall.

3.12 FLOOR BOX INSTALLATION

A. Set boxes level and flush with finish flooring material.

B. Use cast floor boxes for installation in slab on grade. Trim shall match floor covering to be used.

3.13 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.14 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.15 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 260543
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Direct-buried conduit, ducts, and duct accessories.
   2. Concrete-encased conduit, ducts, and duct accessories.
   3. Handholes and boxes.
   4. Manholes.

1.2 ACTION SUBMITTALS

A. Shop Drawings:
   1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
      a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
      b. Include duct entry provisions, including locations and duct sizes.
      c. Include cover design.
      d. Include grounding details.
      e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.3 INFORMATIONAL SUBMITTALS

A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

D. Source quality-control test reports.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.5 FIELD CONDITIONS

A. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

A. Comply with ANSI C2.

2.2 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ARNCO Corp.
   2. Beck Manufacturing.
   3. Cantex, Inc.
   4. CertainTeed Corporation.
   5. Condux International, Inc.
   6. ElecSys, Inc.
   7. Electri-Flex Company.
   8. IPEX Inc.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-80, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.

C. Duct Accessories:
   1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
   2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
   3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 75 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
      a. Color: Red dye added to concrete during batching.
      b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Christy Concrete Products.
   2. Elmhurst-Chicago Stone Co.
   3. Oldcastle Precast Group.
   4. Rinker Group, Ltd.
   5. Riverton Concrete Products.
   6. Utility Concrete Products, LLC.
   7. Utility Vault Co.
   8. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
   1. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
      a. Cover Hinges: Concealed, with hold-open ratchet assembly.
      b. Cover Handle: Recessed.
   2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   3. Cover Legend: Molded lettering, "ELECTRIC.", "TELEPHONE." as indicated for each service on the documents.
   4. Configuration: Units shall be designed for flush burial and have integral closed bottom.
   5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
      a. Extension shall provide increased depth of 12 inches (300 mm).
      b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
   6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
    1. Color: Gray.
    2. Configuration: Units shall be designed for flush burial and have integral closed bottom.
    3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
    4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    5. Cover Legend: Molded lettering, "ELECTRIC.", "TELEPHONE." As indicated for each service.
    6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
    7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
    8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
    1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
    2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
        a. Armorcast Products Company.
        b. Carson Industries LLC.
        c. NewBasis.
        d. Quazite: Hubbell Power System, Inc.

2.6 PRECAST MANHOLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Christy Concrete Products.
    2. Elmhurst-Chicago Stone Co.
    3. Oldcastle Precast Group.
    4. Rinker Group, Ltd.
    5. Riverton Concrete Products.
    6. Utility Concrete Products, LLC.
    7. Utility Vault Co.
    8. Wausau Tile Inc.

B. Comply with ASTM C 858.

C. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

D. Precast Manholes: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

E. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
   1. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
   2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   3. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

F. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1. Type and size shall match fittings to duct or conduit to be terminated.
   2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

G. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.

H. Ground Rod Sleeve: Provide a 3-inch (75-mm) PVC conduit sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the ducts routed from the facility.

I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the groundwater level at grade.

2.7 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bilco Company (The).
   2. Campbell Foundry Company.
   3. Christy Concrete Products.
   4. East Jordan Iron Works, Inc.
   5. Elmhurst-Chicago Stone Co.
   6. McKinley Iron Works, Inc.
   7. Neenah Foundry Company.
   8. NewBasis.
   9. Oldcastle Precast Group.
   10. Osburn Associates, Inc.
   11. Pennsylvania Insert Corporation.
   12. Quazite:Hubbell Power Systems, Inc.
   13. Rinker Group, Ltd.
   14. Riverton Concrete Products.
   15. Underground Devices, Inc.
   16. Utility Concrete Products, LLC.
   17. Utility Vault Co.
   18. Wausau Tile Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
   1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches (660 mm).
      a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
      b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
   2. Cover Legend: Cast in. Selected to suit system.
      a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
      b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
      c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
   3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
b. Seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.

C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

D. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.

E. Ground Rod Sleeve: 3-inch (75-mm), PVC conduit sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the ducts routed from the facility.

F. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

G. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
1. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

H. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

I. Fixed Manhole Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, hot-dip galvanized steel.

J. Cover Hooks: Light duty, designed for lifts less than 60 lbf (270 N). Two required.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-80-PVC, in concrete-encased duct bank.

B. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:
   1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.
   2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
   3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
   4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin vertical loading.
   5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast concrete.
   1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
   2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT INSTALLATION

A. Install ducts according to NEMA TCB 2.

B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12.5 feet (4 m), both horizontally and vertically, at other locations.

D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

E. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
   1. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch (19 mm).
   2. Grout end bells into structure walls from both sides to provide watertight entrances.

F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

H. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
   2. Width: Excavate trench 12 inches (300 mm) wider than duct bank on each side.
   3. Width: Excavate trench 3 inches (75 mm) wider than duct bank on each side.
   4. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
   5. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
   6. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than [four] [five] spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   7. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
   8. Elbows: Use manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.

9. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
12. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover at top and bottom, and a minimum of 2 inches (50 mm) on each side of duct bank.
13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (15-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

J. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

K. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:
    1. Comply with ASTM C 891, unless otherwise indicated.
    2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
    3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
    1. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.
    2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
    3. Install handholes with bottom below the frost line.
    4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
    5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

G. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with anchors extending below depth of frost line of 48 inches (122 cm) below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
   2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull aluminum mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 260544
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413, "Penetration Firestopping," for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   1. Material: Galvanized sheet steel.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

G. STI EZ-Path enclosed fire-rated device, containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to adjust, remove, or reinstall firestop materials. The pathway shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).
   1. Series 22: 1.5 inches (38 mm) high x 1.5 inches (38 mm) wide x 10.5 inches (267 mm) long, volume expansion of fire seal 40 times, inserts into 2 inch (51 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 25 CAT5 cables.
   2. Approved Equals: Hilti.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Proco Products, Inc.
   2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

H. All cable bundles shall utilize an enclosed fire rated pathway device whenever said cables penetrate rated walls.

3.2 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. As an overall scope for the project, provide identification to match the existing standards of the facility. Refer to information below when a standard has not already been established. Provide color, type and sizes at a minimum to match existing.

B. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.3 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project to match existing standards.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters.
2. Legend: Indicate voltage and system or service type.

C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Arc Flash Electrical Equipment Use, Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Interior Use, Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Exterior Use, Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

2.5 INSTRUCTION SIGNS

A. Engraved, plastic laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) or 8 inches in length; 1/8 inch (3.2 mm) thick for larger sizes.
   1. Engraved legend:
      a. Black letters on white face for normal power.
      b. White letters on red face for emergency power.
      c. White letters on green face for grounding.
      d. Black letters on yellow face for Caution or UPS.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting with colors, legend and size required for application. Minimum letter height shall be 3/8 inch (10 mm).

2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
   1. Minimum Width: 3/16 inch (5 mm).
   2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
   3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
   4. Color: Black except where used for color-coding.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 Painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering and colors as required by code. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

D. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system voltage and identity of contained circuits on outside of box cover. Labeling shall be permanent marker (color coded), neatly hand printed or machine labled. All fire alarm boxes shall have covers painted/pre-finished red. All temperature control boxes shall have covers painted blue.

E. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

H. Circuit Identification: Tag or label conductors as follows:

1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
3. Match identification markings with designations used in panelboards shop drawings, Contract Documents and similar previously established identification schemes for the facility's electrical installations.

I. Apply Warning, Caution and Instruction signs as follows:

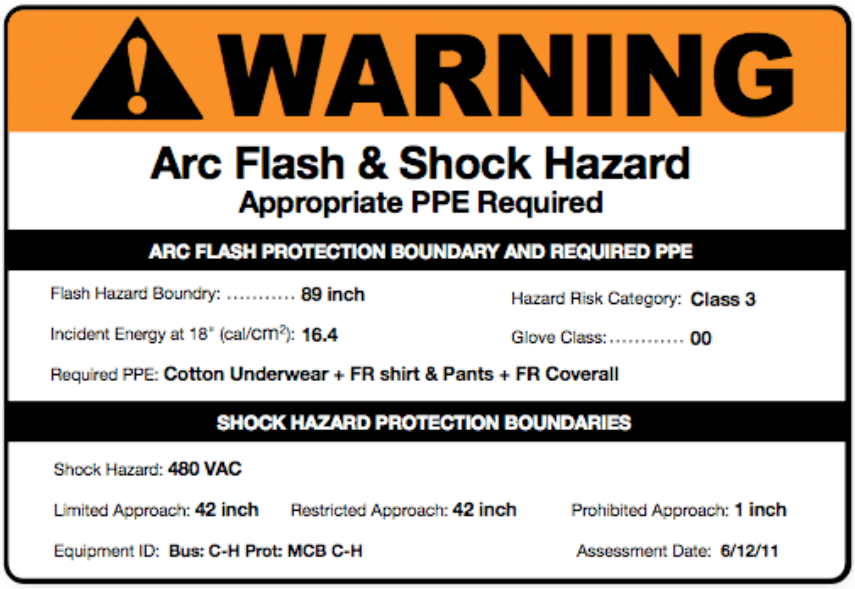
1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engrave laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding or other emergency operations.

J. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, enclosed circuit breakers, pushbuttons, pilot lights, motor controllers and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.

K. Install labels parallel to equipment lines at locations as required and at location for best convenience of viewing without interference with operation and maintenance of equipment.

L. Provide ARC FLASH WARNING signs on all switchboards, panelboards, industrial control panels, and motor control centers. Sign at minimum shall contain:

Sample Arc Flash Hazard Label



M. Circuits with more than 600V: Identify raceway and cable with “DANGER – HIGH VOLTAGE” in black letters 2 inches high on orange back ground at 10’-0” intervals.
   1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to conduits concealed within wall.
   3. All accessible surfaces of concrete envelop around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

N. Underground Electrical Lines: For exterior underground power, control, signal and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

O. Cable Ties: For attaching tags. Use general purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

3.2 RECEPTACLE COVER PLATES

A. Provide identification on all receptacle coverplates indicated. Identification shall indicate source and circuit number serving the device (i.e. “L1A-24”)

B. Identification material to be clear, 3/8-inch Kroy tape or Brother self-adhesive lable with black letters in normal size “Swiss Bold” font. Letter and number size to 3/16-inch high. Embossed Dymo-Tape lables are not acceptable.

C. Permanently affix identification label to cover plates, centered above the receptacle openings.

3.3 CONDUIT COLOR CODING SCHEDULE

A. This Contractor shall furnish and install four (4) framed 8" x 10" charts of the color coded identification scheme used for the electrical system. Install a chart adjacent to the each main switchboard in the facility, at the main fire alarm panel, and two to be located as directed by the Owner.

3.4 CONDUCTOR COLOR CODING - IDENTIFICATION SCHEDULE

A. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.

B. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders and branch circuits, shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel, in colors specified below. The tape shall be applied at each conductor termination with two 1-inch tape bands at 6-inch centers. Contractor option to use colored cabling in lieu of the tape at each end for conductor 6 AWG to 500 KCM.

C. Wire and cables smaller than 6 AWG shall be color coded by the manufacturer.

D. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.

E. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multiwire branch circuit, where accessible, shall be identified by phase and system.

F. Color-Coding for Identification, 600 V and Less: Use the colors listed below for ungrounded branch and feeder circuit conductors.
   1. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.

c. Phase C: Blue.
d. Neutral: White.
e. Ground Bond - Green

2. Colors for 480/277-V Circuits:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: Gray.
   e. Ground Bond - Green

3.5 ELECTRICAL GEAR LABELING

A. This means of identification shall be permanently posted at each branch circuit panelboard. The identification shall be engraved plastic-laminated labels, 1/16-inch minimum thickness with colors corresponding to panel nameplate Letter and number size to 1/8-inch high in normal size “Swiss Bold” font.

B. Main and distribution panelboards, and switchboards shall have each circuit identified with the load being served. The identification shall be engraved plastic-laminated labels, 1/16-inch minimum thickness with colors corresponding to panel nameplate. Letter and number size to 1/8-inch high in normal size “Swiss Bold” font.

C. Electrical disconnects, motor controls, drives, starters, transformers, and circuit breakers shall be identified by load being served and circuit identified with the load being served. The identification shall be engraved plastic-laminated labels, 1/16-inch minimum thickness with colors corresponding to panel nameplate. Letter and number size to be 1/8-inch high in normal size “Swiss Bold” font. For example, a DS-30 serving as a disconnect for water heater WH-1 shall have a nameplate stating WH-1 followed by the circuit number.

D. Branch panelboards shall be provided with typed panel schedules upon a completion of the project. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to 26 05 00 for other requirements.

E. Exterior electrical gear shall be identified with label names and numbers to be visible on the exterior of the gear. The labels shall correspond to the 1-line nomenclature and identify each cubicle of multi-section gear.

F. Lighting poles and flood lights shall be individually identified with a unique number, for maintenance purposes. Apply the label number above the hand hole cover or 24” above grade. Bollards may be identified with a number applied inside the luminaire that is visible from the exterior.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-Adhesive, Baked-enamel warning signs.
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Controls with external control power connections.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
   a. Enclosures and electrical cabinets.
   b. Access doors and panels for concealed electrical items.
   c. Enclosed switches.
   d. Enclosed circuit breakers.
   e. Enclosed controllers.
   f. Push-button stations.
   g. Contactors.
   h. Remote-controlled switches, dimmer modules, and control devices.
   i. Monitoring and control equipment.
   j. Disconnects for any equipment provided by Owner or other trade.

END OF SECTION

SECTION 260572
OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

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 a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

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

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals [shall] [may] be in digital form.

1. Short-circuit study input data, including completed computer program input data sheets.
2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
    a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
    b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [Short-Circuit Study Software Developer] [Short-Circuit Study Specialist] [Field Adjusting Agency].

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE

A. Software Developers: Subject to compliance with requirements, [provide software by the following] [provide software by one of the following] [available software developers offering software that may be used for the Work include, but are not limited to, the following]:

1. ESA Inc.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.
5. <Insert computer software developer's name>.

B. Comply with IEEE 399 and IEEE 551.

C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Comments and recommendations for system improvements, where needed.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.

G. Short-Circuit Study Output:
   1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. Equivalent impedance.
   2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated symmetrical fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. Calculated asymmetrical fault currents:
         1) Based on fault-point X/R ratio.
         2) Based on calculated symmetrical value multiplied by 1.6.
         3) Based on calculated symmetrical value multiplied by 2.7.
   3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated symmetrical fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. No AC Decrement (NACD) ratio.
      e. Equivalent impedance.
      f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
      g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 EXECUTION

3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.
   1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
   2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
   3. For [relocated]equipment [and]that [which]is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
   1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Obtain electrical power utility impedance at the service.
   3. Power sources and ties.
   4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
   5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
   6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.

7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
   1. To normal and emergency systems low-voltage load buses where fault current is 10 kA or less.
   2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.
   3. <Insert description>.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
   1. Electric utility's supply termination point.
   2. Incoming switchgear.
   3. Unit substation primary and secondary terminals.
   4. Low-voltage switchgear.
   5. Motor-control centers.
   6. Control panels.
   7. Standby generators and automatic transfer switches.
   8. Branch circuit panelboards.
   9. Disconnect switches.
   10. <Insert significant locations in the system>.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION

SECTION 260574
OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Provide study for the entire distribution system.

1.2 DEFINITIONS

A. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

C. SCCR: Short-circuit current rating.

D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

B. Operation and Maintenance Procedures: In addition to items specified in Section 017823, "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by the following:

1. Power systems study shall be completed in SKM - Power Tools for Windows (PTW) 6.5.1 or later version or pre-approved equivalent program.

B. Comply with IEEE 1584 and NFPA 70E.

2.2 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 EXECUTION

3.1 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Perform and use the short-circuit study output and the field-verified settings of the overcurrent devices.

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include low-voltage equipment locations, except 240-V ac and 208-V ac systems fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.2 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis:
   1. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
   1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Obtain electrical power utility impedance at the service.
   3. Power sources and ties.
   4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
   5. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
   6. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
   7. Motor horsepower and NEMA MG 1 code letter designation.
   8. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.3 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
   1. Switchboard.
   2. Panelboards.

3.4 TRAINING

A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

3.5 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

END OF SECTION

SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Time switches.
   2. Photoelectric switches.
   3. Indoor occupancy sensors.
   4. Outdoor motion sensors.
   5. Lighting contactors.

B. Related Requirements:
   1. Section 262726, "Wiring Devices," for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

C. All occupancy sensors. Light level sensors, daylight stations, wall switch stations, architectural preset scene controllers, key switch control stations, etc., shall be "Network Lighting Control" lighting system control devices to be from the same manufacturer.

1.2 DEFINITIONS

A. LED: Light emitting Diode

B. PIR: Passive Infrared.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.8 COMMISSIONING

A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.

B. This project will have selected building systems commissioned. The Contractor is responsible to execute commissioning.

C. System shall be functionally tested by a factory-authorized engineer. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

1.9 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a minimum period of two (2) years from date of commissioning.

PART 2 PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Wattstopper
   2. Sensor Switch

B. Description: Solid state, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
   3. Time Delay: Fifteen second minimum, to prevent false operation.
   4. Surge Protection: Metal-oxide varistor complying with IEEE C62.41.1, IEEE C62.41.2 and IEEE 62.45 for category A1 locations.
   5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Sensor Switch, Inc.
   2. Wattstopper

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-units with a separate relay unit.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
   4. Mounting:
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   5. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
   6. Bypass Switch: Override the "on" function in case of sensor failure.
   7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
   1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).

2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lutron
2. Wattstopper
3. Sensor Switch.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent or LED at 120 V, 1200-VA fluorescent or LED at 277 V.

2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch (21 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553, "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to assist in testing and inspecting components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 3 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
   2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.6 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943, "Network Lighting Controls."

B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Training duration shall be no less than (3) visits at eight hours each, with (1) day being scheduled at least (2) weeks after initial training.

END OF SECTION

SECTION 260943
NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.

B. The system shall be capable of turning lighting loads on/off as well as dimming lights.

C. All system devices shall be networked together enabling digital communication and shall be individually addressable.

D. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.

E. The system architecture shall facilitate remote operation via a computer connection.

F. The system shall not require any centrally hardwired switching equipment.

G. The system shall include Building Management System gateway software via BACnet communication or compatible equivalent.

H. Provide the sensor quantities and types required to accomplish lighting control that are consistent the design intent as shown. Coordinate locations of equipment and control points such as line voltage relays and lighting switch legs to ensure the modifications to the design intent are accomplished.

I. Related Sections:

1. Division 26 Section "Lighting Control Devices" for time clocks, photoelectric sensors, occupancy sensors, and daylight/light level sensors.

1.2 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. BAS: Building automation system.

C. DALI: Digital addressable lighting interface.

D. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

F. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

G. PC: Personal computer; sometimes plural as "PCs."

H. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

I. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

J. TCP/IP: Transmission Control Protocol/Internet Protocol. The standard for transmitting data over networks, typically made up of many different protocols.

K. UTP: Unshielded twisted pair.

1.3 SYSTEM DESCRIPTION

A. Provide a lighting control system as described in this specification and as indicated on the drawings. All lighting control equipment shall be provided to form a complete system ready for operation. It shall include, but not be limited to, photocells, relay control panels, momentary contact switches, wiring, digital addressable lighting control components, etc.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, digital address lighting control network materials, manual switches and plates, and conductors and cables.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
2. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
3. Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices).
4. Other Diagrams – as needed for special operation or interaction with other system(s).
5. Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up.
6. Hardware and Software Operation Manuals.
7. Other operational descriptions as needed.

C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
2. List networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

D. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

E. Field quality control test reports.

F. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. All components and the manufacturing facility where product was manufactured must be ROHS compliant.

E. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

F. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

G. Comply with NFPA 70.

H. Sensors and Devices

1. It is the responsibility of the Manufacturer of photocells and vacancy sensors to review sensor types, quantities, and mounting locations ensuring the design intent is met. The Manufacturer shall provide recommendations and identify substitutions or variances to the design intent.

1.6 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of lighting control functions.

B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

C. Coordinate lighting controls with BAS either through IP based intercommunication of system or hardwired auxiliary relay outputs.

D. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.7 COMMISSIONING

A. System shall be functionally tested by a factory-authorized engineer. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system

1.8 WARRANTY

A. All devices in lighting control system shall have a 5 year warranty.

B. Any additional equipment required to replace equipment being removed within the warranty period shall be provided at no expense to the Owner.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Equal to 2% percent of amount installed, but no fewer than 2 devices.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for five years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.

1. Provide 30-days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. This specification is based on the nLight® Network Control System from Sensor Switch, an Acuity Brands Company (800-727-7483, www.sensorswitch.com).

2. Or approved prequalified equivalent.

2.2 SYSTEM REQUIREMENTS

A. System shall have an architecture that is based upon three main concepts:
   1. Intelligent lighting control devices.
   2. Stand-alone lighting control zones.
   3. Network backbone for remote or time based operation.

B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

C. Intelligent lighting control devices shall communicate digitally, require ~3 mA of current to function (Graphic WallPod excluded), and possess at least two RJ-45 connectors.

D. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

E. Devices within a lighting control zone shall be connected with plenum rated CAT-5 low voltage cabling, in a daisy-chain fashion, and in any order.

F. Lighting control zone shall be capable of automatically configuring itself for default operation.

G. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

H. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.

I. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

J. System shall have a primary wall mounted network control “gateway” device that is capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

K. System shall use “bridge” devices that route communication and distribute power for up to 8 lighting zones together for purposes of decreasing system wiring requirements.

L. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

M. Individual lighting zones shall be capable of being segmented into several channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

N. System shall be capable of operating a lighting control zone according to several sequences of operation. Note operating modes should be utilized only in manners consistent with local energy codes:
   1. Auto-On / Auto-Off (via occupancy sensors)
   2. Manual-On / Auto-Off
   3. Auto-to-Override On
   4. Manual-to-Override On
   5. Auto On/Predictive Off
   6. Multi-Level On (multiple lighting levels per manual button press)

O. A taskbar style desktop application shall be available for personal lighting control.

P. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

Q. Control software shall be integrated with the BAS via BACnet IP.

2.3 CONTROL MODULE (GATEWAY)

A. Control Module Description: Module shall be a wall mounted user accessible device that is capable of communicating and controlling downstream system control devices and linking into an Ethernet.

B. Devices shall be powered by low voltage, fit within a two gang switch box (or mounting ring), and have a backlit LCD panel.

C. User control shall be made available via finger-touch buttons with no moving parts. Buttons shall be capable of being locked for security.

D. Device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to a lighting control zones device.

E. Device shall automatically detect all devices downstream of it.

F. Device shall have a standard and astronomical internal time clock.

G. Device shall have one RJ-45 10/100 BaseT Ethernet connection.

H. Each control gateway device shall be capable of linking 400 devices to the management software.

I. Device shall be capable of using a dedicated or DHCP assigned IP address.

J. Network Control Gateway device shall be the following Sensor Switch model number:

1. nGWY

2.4 NETWORKED SYSTEM OCCUPANCY SENSORS

A. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

B. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

C. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.

D. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.

E. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

F. Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.

G. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.

H. Sensors shall be available in multiple lens options which are customized for specific applications.

I. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

J. All sensors shall have two RJ-45 ports.

K. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue

L. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.

M. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.

N. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.

O. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.

P. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

Q. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.

R. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)

S. Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified:

1. **nWSD** (PIR, 1 Relay)
2. **nWSD PDT** (Dual Technology, 1 Relay)
3. **nWSD 2P** (PIR, 2 Relays)
4. **nWSD PDT 2P** (Dual Technology, 2 Relays)
5. **nWSD NL** (PIR w/ Night Light, 1 Relay)
6. **nWSD PDT NL** (Dual Technology w/ Night Light, 1 Relay)
7. **nWSD LV** (PIR, No Relay)
8. **nWSD PDT LV** (Dual Technology w/ Night Light, No Relay)

T. Network system shall also have ceiling, fixture, recessed, and corner-mounted sensors available.

U. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

V. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).

W. Sensors shall be the following Sensor Switch model numbers, with device options as specified:

Model # Series	Occupancy Poles	# of Relays	Lens Type	Detection Technology
nCM(B) 9	1	-	Standard	PIR
nCM(B) 9 2P	2	-	Standard	PIR
nCMR(B) 9	1	1	Standard	PIR
nCMR(B) 9 2P	2	2	Standard	PIR
nCM(B) PDT 9	1	-	Standard	Dual
nCM(B) PDT 9 2P	2	-	Standard	Dual
nCMR(B) PDT 9	1	1	Standard	Dual
nCMR(B) PDT 9 2P	2	2	Standard	Dual
nCM(B) 10	1	-	Extended	PIR
nCM(B) 10 2P	2	-	Extended	PIR
nCMR(B) 10	1	1	Extended	PIR
nCMR(B) 10 2P	2	2	Extended	PIR
nCM(B) PDT 10	1	-	Extended	Dual
nCM(B) PDT 10 2P	2	-	Extended	Dual
nCMR(B) PDT 10	1	1	Extended	Dual
nCMR(B) PDT 10 2P	2	2	Extended	Dual
nWV 16	1	-	Wide View	PIR
nWV PDT 16	1	-	Wide View	Dual

nHW13	1	-	Hallway	PIR
nCM(B) 6	1	-	High Bay	PIR
nCMR(B) 6	1	1	High Bay	PIR
nCMR(B) 6 2P	2	2	High Bay	PIR
nCMR(B) 6 480	1	2	High Bay	PIR

Note: Recessed mount versions of the above ceiling (fixture) mount versions also shall be available (e.g. nCMR(B) 9 => nRMR 9)

2.5 NETWORKED SYSTEM DAYLIGHT (PHOTOCELL AND OR DIMMING) SENSORS

A. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

B. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.

C. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

D. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).

E. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)

F. Combination units that have all features of on/off photocell and dimming sensors shall also be available.

G. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.

H. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.

I. Sensor shall be the following Sensor Switch model numbers, with device options as specified:

1. **nCM(B) PC** (on/off))
2. **nCM(B) ADC** (dimming)
3. **nCM(B) PC ADC** (on/off, 0-10 VDC dimming)
4. **nCMR(B) PC** (on/off, single relay)
5. **nCMR(B) PC ADC** (on/off, 0-10 VDC dimming, single relay)

Note: Recessed mount versions of the above ceiling (fixture) mount versions also shall be available (e.g. nCMR(B) PC => nRMR PC)

2.6 NETWORKED SYSTEM POWER (RELAY) PACKS

A. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.

B. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.

C. All devices shall have two RJ-45 ports.

D. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.

E. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

F. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

G. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all load types, and be rated for 400,000 cycles.

H. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts.

I. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).

J. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.

K. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.

L. Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers:
   1. **nPP16** (Power Pack w/ 16A relay)
   2. **nSP16** (Secondary Pack w/ 16A relay)
   3. **nSP16 SA** (Secondary Pack w/ 16A relay, Manual On)
   4. **nSP5 2P** (Secondary Pack w/ two 5A relays)
   5. **nSP5 D** (Secondary Pack w/ 5A relay and 0-10VDC dimming output)
   6. **nSP5 PCD 2W** (Secondary Pack w/ 5A relay and incandescent dimming or 2-wire line voltage fluorescent dimming output)
   7. **nSP5 PCD 3W** (Secondary Pack w/ 5A relay and 3-wire line voltage fluorescent dimming output)
   8. **nSP5 480** (Secondary Pack w/ 5A relay for switching 208/240/480 VAC loads
   9. **nPS 80** (Power Supply)
   10. **nAR 40** (Low voltage auxiliary relay pack)

2.7 NETWORKED SYSTEM WALL SWITCHES AND DIMMERS

A. Devices shall recess into single-gang switch box.

B. Devices shall be available with zero or one integrated Class 1 switching relay.

C. Communication and low voltage power shall be delivered to each device via plenum rated CAT-5 low voltage cabling with RJ-45 connectors.

D. All sensors shall have two RJ-45 ports.

E. All devices shall provide toggle switch control. Provide dimming (raise/lower) control and low temperature/high humidity rated devices in applicable environment locations shown.

F. Devices shall be available in four standard colors (Ivory, White, Light Almond, Gray), provide in color(s) as selected by Architect.

G. Devices with dimming control outputs can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).

H. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.

I. Devices with mechanical push-buttons shall provide tactile and LED user feedback.

J. Devices with mechanical push-buttons shall be made available with custom button labeling

K. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

L. Wall switches and dimmers shall be the following Sensor Switch model numbers, with device options as specified:

1. **nPOD** (single on/off, capacitive touch, audible user feedback)
2. **nPOD 2P** (dual on/off, capacitive touch, audible user feedback)
3. **nPODR** (single on/off, one relay, capacitive touch, audible user feedback)
4. **nPODM** (single on/off, push-buttons, LED user feedback)
5. **nPODM 2P** (dual on/off, push-buttons, LED user feedback)
6. **nPODM DX** (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
7. **nPODM 2P DX** (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
8. **nPODM 4P** (quad on/off, push-buttons, LED user feedback)

2.8 NETWORKED SYSTEM SCENE CONTROLLERS

A. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.

B. Device shall recess into single-gang switch box and fit a standard GFI opening.

C. Devices shall provide LED user feedback.

D. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

E. All sensors shall have two RJ-45 ports.

F. Device shall have four touch sensitive buttons for selecting programmable lighting control scenes/profiles.

G. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.

H. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).

I. Device shall have LEDs indicating current selection.

J. Scene Selector device shall be the following Sensor Switch model number:

1. **nPODS** (4 Scene, capacitive touch)
2. **nPODM 2S** (2 Scene, push-button)
3. **nPODM 4S** (4 Scene, push-button)

2.9 COMMUNICATION BRIDGES

A. Device shall surface mount to a standard 4" x 4" square junction box.

B. Device shall have 8 RJ-45 ports.

C. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.

D. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.

E. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

F. Communication Bridge devices shall be the following Sensor Switch model numbers:

1. **nBRG 8** (8 Ports)

2.10 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 6 for horizontal copper cable and with Division 27 Section "Structured Cabling."

C. Connection Type: RS-485 protocol, category 5 UTP cable, using RJ45 connectors. Power shall be from the control unit.

2.11 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.12 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.

I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network).

K. Management Software file server provided by successful manufacturer, suitable for application and by approval of specifications from the Owner's IT Department. Coordinate the specific minimum performance hardware needs.

2.13 BMS COMPATIBILITY

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.14 SYSTEM ENERGY ANALYSIS AND REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or CO2.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented.

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and schedules.

K. Data shall be made available via a .CSV file.

2.15 START-UP AND SUPPORT FEATURES

A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

D. All system devices shall be capable of being given user defined names.

E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: For low voltage communication/signal cabling in raceways with minimum 3/4 inch (22 mm) conduit size.
   1. For power wiring comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
   2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Division 26 Section "Control-Voltage Electrical Power Cables."
   3. Cat 5 lighting control cabling may be installed with free-air cabling means and methods specified with in Division 26 and 27, where not subject to damage and concealed.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

F. Coordinate installation of ceiling mounted photocells and occupancy sensors with light fixtures, HVAC diffusers, sprinkler heads, speakers, smoke detectors, and etc.

G. All wiring within panels shall be neatly bundled and harnessed along the cabinet sides to provide a well-organized, clean installation.

H. All relays and inputs shall be labeled.

I. Provide a machine-printed and laminated directory along with a color 11 by 17-inch plan of the areas with lighting controls. The plan shall identify the control zones by (relay) power pack using the same nomenclature used in the panel labels. Shade each control zone and relay with a different color, matching the relay to the zone. Apply the same color labels to the actual relays and to the sensors in the form of ½-inch circular adhesive-backed dots. Provide a copy of directory to Aurora Facility Management Personnel. Also provide a copy with the Project's Operation and Maintenance (Owner's) Manual.

J. Label control devices as specified in Division 26 Section "Identification for Electrical Systems."

K. Label location of remote (relay) pack concealed behind accessible ceilings on room finished side identified for Facilities Maintenance personnel servicing purposes with a discrete, mechanically prepared, identification means approved by Aurora Facility Management Personnel.

3.2 FIELD QUALITY CONTROL

A. Before notifying the Engineer that the lighting control system is ready for testing, perform an on-site system check to ensure that all sensors, relays, etc. connected to the lighting control system are functioning properly. Upon completion of the installation and final programming the Contractor shall perform a complete test. This test shall verify that each and every function and feature of the system works properly. The Engineer and Owner shall be notified a minimum of (7) working days prior to final testing so that they may witness the testing.

B. The Contractor shall perform a complete test prior to system commissioning. Division 26 must be present for testing of this system to verify and trouble shoot lighting relay components and power supplies. When troubleshooting is required provide it in collaboration with the Electrical Contractor. This test shall verify that each and every function and feature of distributed lighting controls works properly with the BMS system. The Engineer and Owner shall be notified a minimum of (7) working days prior to final testing so that they may witness the testing.

C. Training shall be scheduled only after the system has passed final testing and has been witnessed by the Owner and Engineer.

D. Perform tests and inspections:
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections:
   1. Test for circuit continuity.
   2. Verify that the control module features are operational.
   3. Check operation of local override controls.
   4. Test system diagnostics by simulating improper operation of several components selected by Architect.

F. Lighting controls will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports

3.3 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 3 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two, eight hour visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for control systems. See Division 01 Section "Demonstration and Training."

B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Training duration shall be no less than three, six hour days, with one (1) day being scheduled at least (2) weeks after initial training.

3.6 OWNER TRAINING

A. After final testing and adjustments have been completed, a factory-authorized service representative shall provide a video recorded training, with accompanying digital media instruction for the care, adjustment, and operation of all parts of the system to the Owner’s personnel.

END OF SECTION

SECTION 262416
PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Distribution panelboards.

1.2 DEFINITIONS

A. SPD: Surge protection device.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include wiring diagrams for power, signal, and control wiring.
   6. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field Quality Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Four spares for each type of panelboard cabinet lock.
   2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, when work in spaces are complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
   b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

1.10 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface-mounted cabinets:

1. Rated for environmental conditions at installed location
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Other Outdoor, Wet or Damp Indoor Locations: NEMA 250, Type 4X.
2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Same finish as panels and trim.
5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top.

C. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Match existing, Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

G. Branch Overcurrent Protective Devices: Fused switches as indicated.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Match existing brand, Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.
4. Molded-Case Circuit Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
   d. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
   e. Handle Padlocking Device: Fixed attachment, for locking circuit breaker handle in on or off position.
   f. Handle Clamp: Loose attachment, for holding circuit breaker handle in on position.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Equipment Mounting: Install floor mounted panelboards on concrete bases, 4-inch (100-mm) nominal thickness.
   1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to panelboards.
   3. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box.

E. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Operating Handle of highest circuit breaker, in the ON position, shall not exceed 6 feet above finished floor or grade.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Submit report to show emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.

G. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

H. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment,anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make on site circuit changes that were outside the original scope of the project or were field initiated and installed.

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 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

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 to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 262726
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Wall-box motion sensors.

1.2 DEFINITIONS

A. EMI: Electromagnetic Interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radiofrequency Interference.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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.

1.4 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper: AH8300.
      b. Hubbell: HBL8300.
      c. Leviton: 8300.
      d. Pass & Seymour: 8300.

   Series numbers listed are given to establish quality level of devices. Other manufacturers may supply devices that are equal.

Description: Hospital grade as indicated by U.L. green dot marking. Receptacles shall have wire bundling clamp on all terminals including ground. Terminal screws shall be #10. A full wrap-around bridge strap shall be provided with locking finger tabs to secure the face. Ground contact spring shall be formed on bridge, riveted grounds contact spring are not acceptable. Device must have an ID labeling area to positively identify the circuit. Face and back body shall be impact resistant nylon.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that indicates energized status.

B. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; HGF20.
   b. Hubbell; HGF8300.
   c. Leviton; 7899-HG.
   d. Pass & Seymour; 2095-HG.

2.4 SNAP SWITCHES

A. Comply with NEMA WD1and UL 20.

B. Switches, 120/277V, 20A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

	Single Pole	Double Pole	3-Way	4-Way
Cooper	2221	2222	2223	2224
Hubbell	CS1221	CS1222	CS1223	CS1224
Leviton	1221-S	1222-S	1223-S	1224-S
Pass & Seymour	PS20AC1	PS20AC2	PS20AC3	PS20AC4

Description: Switches shall be rated for 20 amperes with thermoplastic abuse resistant toggle, quiet action, and heavy duty contact arm. Switches shall have quiet action mechanism with silver alloy contacts for longevity. Terminal screws shall side wire and accept #14, 12, and 10 AWG stranded or solid wire. Family of switches shall include: single pole, double pole, 3-way, 4-way.

2.5 WALL PLATES

A. Single and combination types match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth brushed stainless steel material.

2.6 FINISHES

A. Color:

1. Wiring Devices connected to Normal Power system: Black or Brown.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
   5. When there is a choice, use side wiring with binding-head screw terminals.
   6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

H. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for rough-in of conduit and equipment, the contractor shall check with other contractors concerned, to determine exact field location of the above items. In addition, he shall check for exact direction of door swings so that local switches are properly located on the strike side.

I. Where more than one wiring device occurs in any one location, arrange devices in gangs with common cover plate, excluding wall box dimmers. Where ganged switches serving 277V lighting are served by different circuits, so as to result in the voltage between switches exceeding 300V, provide barriers in box per NEC Section 404-8(b).

J. In locations where several pieces of wall-mounted equipment such as wall switches and thermostats are in the same general area, all shall be installed and grouped in a neat, orderly fashion, all of the same horizontal or vertical center line, whichever the case may be. Variation from this direction shall be approved by the owner or the owner's representative. All receptacles and switches shall be mounted at a height as directed in drawings.

K. Install devices, accessories, and assemblies' level, plumb, square with building lines, and secure.

L. Install tamper resistant devices in all pediatric areas, psych/behavioral/holding, and general waiting rooms.

M. Install GFCI type receptacles where located in bathrooms, kitchens, or within six feet of a water source.

N. Install GFCI type receptacle with an in-use weatherproof cover for all receptacles indicated as weatherproof.

O. Devices mounted in boxes which are not flush with the surface of the wall shall be installed so that the mounting yoke or strap of the device is held rigidly at the surface of the wall, but not supported by the wall. Provide washers or spacers to fill in the area between the box and the finished wall line.

P. Receptacles shall be installed so that the removal of the receptacle does not interrupt the continuity of the circuit.

3.2 IDENTIFICATION

A. Install nameplate identification to receptacle cover plates indicated. Identification shall note panel name and circuit number both inside the device box as well as the cover plate. Comply with Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
   3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

END OF SECTION

SECTION 262813

FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Cartridge fuses, rated 600 V and less, for use in control circuits and enclosed controllers.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.3 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.4 EXTRA MATERIALS

A. Provide two fuse pullers.

B. Provide three of each size and type of fuses installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Mersen (formerly Ferraz Shawmut, Inc.)
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage rating consistent with circuit voltage.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.

D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.

E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.

F. Control transformer fuses: Class CC (time delay).

G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch- (1.27-mm-) thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
   4. Fuse Pullers: For each size of fuse.
   5. Install spare fuse cabinet in the Main Electrical Room.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Motor Branch Circuits: Class RK5, time delay.

B. Other Branch Circuits: Class RK1, time delay.

C. Control Circuits: Class CC, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and adjacent to each fuse block, socket, and holder.

B. Provide a written index of all required fuses and all spares to be included in Operation and Maintenance Manual.

END OF SECTION

SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Shunt trip switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Molded-case switches.
   5. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

D. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of NRTL listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

E. Shop Drawings: For enclosed switches and circuit breakers.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing manufacturer, Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   5. Hookstick Handle: Allows use of a hookstick to operate the handle.
   6. Lugs: Mechanical type, suitable for number, size, and conductor material.
   7. Service-Rated Switches: Labeled for use as service equipment.
   8. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac.

2.2 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
   3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:
   1. Oiltight key switch for key-to-test function.
   2. Oiltight green ON pilot light.
   3. Isolated neutral lug; 200 percent rating.
   4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
   5. Form C alarm contacts that change state when switch is tripped.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing, Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit breaker contacts, "b" contacts operate in reverse of circuit breaker contacts.
   7. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.
   8. Accessory Control Power Voltage: Integrally mounted, self-powered; 24-V ac

2.4 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing manufacturer on site, Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:
   1. Standard frame sizes and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   5. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
   6. Alarm Switch: One NC contact that operates only when switch has tripped.
   7. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
   8. Accessory Control Power Voltage: Integrally mounted, self-powered; 24-V ac.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 4X.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

C. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit breaker trip ranges as specified in Section 260573, "Overcurrent Protective Device Coordination Study."

END OF SECTION

SECTION 264313
SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 262413 "Switchboards" for factory-installed SPDs.

1.2 DEFINITIONS

A. I(n): Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, nominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall not be less than 115% of the nominal operating voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Current Technology, Inc.
   2. Square D; Schneider Electric
   3. Liebert Corporation, a division of Emerson.

B. SPDs: Comply with UL 1449, Type 1 or Type 2.

C. SPDs: The Project includes a UL Master Label Lightning Protection System with UL 96A Compliance, therefore the SPD's for Service Entrances must be Listed and labeled by UL.
   1. SPDs with the following features and accessories:
      a. Integral disconnect switch.
      b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
      c. Indicator light display for protection status.
      d. Surge counter.

D. Comply with UL 1283.

E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
   1. Line to Neutral: 1200 V for 480Y/277 V.
   2. Line to Ground: 1200 V for 480Y/277 V.
   3. Neutral to Ground: 1200 V for 480Y/277 V.
   4. Line to Line: 2500 V for 480Y/277 V.

G. SCCR: Equal or exceed 200 kA.

H. Nominal Discharge Current Rating, $I_{(n)}$: 20 kA. Nominal Discharge Current Ratings of 3kA, 5kA or 10kA shall not be allowed.

2.3 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 4X.

2.4 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260523 "Control-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260523 "Control-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped pressure connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 260523 "Control-Voltage Electrical Power Conductors and Cables."

3.2 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION

SECTION 265100
INTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior lighting fixtures
   2. LED Diodes, Luminaires, Drivers/power supplies and Dimmers
   3. Emergency lighting units.
   4. Exit signs.
   5. Lighting fixture supports.

B. Related Sections:
   1. Section 260923 "Lighting Control Devices," for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 262726 "Wiring Devices."
   3. Section 260943 "Network Lighting controls," for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.2 REFERENCES

A. Illuminating Engineering Society of North America (IESNA):
   1. LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurements of Solid-Sate Lighting Products.
   2. LM-80-08, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources.

B. National Electrical Manufacturers Association (NEMA):
   1. ANSI/NEMA/ANSLG C78.377-2008 – American National Standard for the Chromaticity of Solid State Lighting Products.

1.3 DEFINITIONS

A. PF: Power factor.

B. CRI: Color-rendering index.

C. LER: Luminaire efficacy rating.

D. Lumen: Measured output of lamp and luminaire, or both.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. RCR: Room cavity ratio.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Drivers.
   4. Energy-efficiency data.
   5. Life, output and energy-efficiency data for lamps.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. For LED luminaires provide absolute photometry of complete luminaire not relative photometry.

b. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
c. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

7. LED drivers including compatibility between lighting dimmers and LED drivers. Provide absolute test data with light module, driver and dimmer.
8. LED thermal management (heat sink) information and requirements from the manufacturer.

B. Product Data: For each type of lamp specified, arranged by light type. Include:

1. Lamp wattage and shape.
2. Lamp voltage where applicable.
3. Rated lamp life.
4. Mean lumen output.
5. Correlated Color Temperature.
6. Color Rendering (CRI)
7. Manufacturer.

C. Installation instructions.

D. Performance Reports – Submit the following for approval:

1. Luminaire photometric reports per IESNA LM-79-08 including: laboratory name, report number, date, luminaire catalog number, luminaire, and light source specifications. Report must contain lumen values in Backlight, Uplight, and Glare (BUG) zones per IESNA TM-15-07 and Roadway Type classifications, luminous Intensity, zonal lumen summary, and an iso-footcandle diagram per LM-31as well as documentation that specified standards and test methods were followed.
2. Provide certification of one of the following:
   a. LM-79-08 report at T=0 and at T=6000 hours with a summary table showing the percent lumen output change and percent input power change.
   b. LM-80-08 test data for the LEDs at the three temperatures per LM-80-08. Provide extrapolation data using an exponential decay function to show the output at 50,000 hours. Provide the Ts value from the LM-79-08 and where the point falls in relation to the LM-80-08 extrapolated data. Interpolate between the LM-80-08 data for the T_s temperature.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting fixtures.
2. Structural members to which suspension systems for lighting fixtures will be attached.
3. Other items in finished ceiling including the following:
   a. Air outlets and inlets.
   b. Smoke and fire detectors.
   c. Occupancy sensors.

B. Field quality control reports.

C. Warranty: Sample of special warranty.

D. Performance Reports – Submit the following for approval:

1. Luminaire photometric reports per IESNA LM-79-08 including: laboratory name, report number, date, luminaire catalog number, luminaire, and light source specifications. Report must contain documentation that specified standards and test methods were followed.
2. Provide certification of one of the following:
   a. LM-79-08 report at T=0 and at T=6000 hours with a summary table showing the percent lumen output change and percent input power change.
   b. LM-80-08 test data for the LEDs at the three temperatures per LM-80-08. Provide extrapolation data using an exponential decay function to show the output at 50,000 hours. Provide the Ts value from the LM-79-08 and where the point falls in relation to the LM-80-08 extrapolated data. Interpolate between the LM-80-08 data for the T_s temperature.

3. Provide safety certification and file number as required for the luminaire family that must be listed, labeled, or identified per the National Electric Code (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Power Supply Units/ driver: One for every 100 of each type and rating installed. Furnish at least one of each type. May be unitized with LEDs.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.9 COORDINATION

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

1.10 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Lighting Unit Batteries: Three years from date of Substantial Completion. Full warranty shall apply for three years.
   2. Warranty Period for Light Sources: Five year replacement material warranty on all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor for the LEDs lumen maintenance not achieving L70 after 50,000 hours.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product by one of the products indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Diffusers and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch (3.175 mm minimum unless otherwise indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Reflecting surfaces: Minimum reflectance's as follows, unless otherwise noted:
      a. White surfaces: 85 percent.
      b. Specular surfaces: 83 percent.
      c. Diffusing specular surfaces: 75 percent.
      d. Laminated silver metalized film: 90 percent.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. CCT and CRI for all luminaires.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.4 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
   1. Battery: Sealed, maintenance-free, lead-acid type.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.
   3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
   7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
   8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

2.5 LED LIGHT SOURCE REQUIREMENTS

A. LED sources must meet the following requirements:
   1. Operating temperature rating must be between -40°C and +50°C
   2. Correlated Color Temperature (CCT):

a. Nominal CCT: 3500 K (3465 ± 245)
3. Color Rendering Index (CRI): greater than or equal to 80.
4. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
   a. High Temperature Operating Life (HTOL)
   b. Room Temperature Operating Life (RTOL)
   c. Low Temperature Operating Life (LTOL)
   d. Powered Temperature Cycle (PTMCL)
   e. Non-Operating Thermal Shock (TMSK)
   f. Mechanical Shock
   g. Variable Vibration Frequency
   h. Solder Heat Resistance (SHR)

2.6 LED DRIVERS/POWER SUPPLY REQUIREMENTS

A. LED drivers must meet the following requirements:
   1. Drivers must have a minimum efficiency of 85%.
   2. Starting Temperature: -40° C.
   3. Electrical Characteristics:
      a. Volts: 277.
      b. Phase: Single.
      c. Hertz: 60.
   4. Power supplies can be UL Class I or II output.
   5. Drivers must have a Power Factor (PF) of greater than or equal to 0.90.
   6. Drivers must have a Total Harmonic Distortion (THD) of greater than or equal to 20%.
   7. Drivers must comply with FCC 47 CFR Part 15 non-consumer RFI/EMI standards.
   8. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
   9. Drivers must comply with requirements in section 2.5 B Controls.

2.7 LED LUMINAIRES

A. Provide luminaires with integral LED thermal management system (heat sinking).

B. Luminaires shall be equipped with an LED driver that accepts 120V through 277V, 50hz to 60hz (UNIV). Component-to-component wiring within the luminaire will carry no more than 80% of rated current and be listed by UL for use at 600 VAC at 302°F/150°C or higher. Plug disconnects shall be listed by UL for use at 600 VAC, 15A or higher.

C. LED modules shall have a minimum L70 service life of 75,000 hours at 25°C ambient temperature and based on IESNA LM-80 methodology.

D. Provide luminaires with individual LED arrays/ modules and drivers that are accessible and replaceable from exposed side of the luminaire. Luminaires requiring removal or replacement of entire luminaire to access LEDs and drivers will NOT be accepted.

E. Warranty: 5 year warranty covering the LED arrays, and LED drivers.

2.8 LED DIMMERS

A. Provide dimmer and driver that are compatible and tested to comply with UL standards.

B. Continuous Flicker Free dimming range (100% to 1%) (100% to 5%) (100% to 10%) measured relative light output.(Note: The only manufacturer that can dim down to 1% currently is Lutron.)Relative humidity: maximum 90% non-condensing.

C. Power factor: greater than .90 at 25W.

D. Total Harmonic Distortion: less than 20% at 25W.

E. Inrush current <2A

F. Sound rating: Inaudible in a 24 dB ambient.

G. Class P thermally protected.

H. Meets FCC Part 15 Non-Consumer requirements for EMI/RFI emissions in a typical grounded fixture

I. Provide dimmers with Pulse Width Modulation for both constant current or constant wattage drivers to maintain LED color when dimming. Unless noted otherwise on the Luminaire Schedule.

2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

C. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

2.10 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.
   1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
   2. Metallic Finish: Corrosion resistant.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA/IESNA-500, “Recommended Practice for Installing Indoor Commercial Lighting Systems.”

B. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Install lamps in each luminaire.

C. Suspended Lighting Fixture Support:
   1. Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
   4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Install all lamps with the power disconnected.

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal. Test from Normal Power to Generator Power and to Normal Power.

B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

D. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

E. Advance Notice: Give dates and times for field tests.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

G. Corroded Fixtures: Replace during warranty period.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner.

3.5 CLEANING

A. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.

3.6 COMMISSIONING

3.7 REBATES

A. Submit Focus On Energy/We-Energies rebate form(s) to Owner with each rebate item information completed. Include all applications, invoices, bill of materials, calculations and information required by rebate sponsoring entity.

3.8 INTERIOR LUMINAIRE SCHEDULE

A. See drawings for Luminaire Schedule.

END OF SECTION

SECTION 265610
LED EXTERIOR LIGHTING

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. Exterior luminaires with LEDs and drivers.
   2. Poles and accessories.

B. Related Sections:
   1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. LER: Luminaire efficacy rating.

D. Luminaire: Complete lighting fixture, including driver housing if provided.

E. Pole: Luminaire support structure, including tower used for large area illumination.

F. Standard: Same definition as "Pole" above.

1.4 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by their basic designation only.

B. American National Standards Institute (ANSI):
   1. ANSI C62.41.1-2002 – IEEE Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits.
   2. ANSI C62.41.2-2002 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000W and less) AC Power Circuits.
   3. ANSI C82.SSL1 – SSL Drivers (in ANSI development).

C. Illuminating Engineering Society of North America (IESNA):
   1. G-1-03, Guidelines for Security Lighting.
   2. LM-64-01, Photometric Measurements of Parking Areas.
   3. LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurements of Solid-Sate Lighting Products.
   4. LM-80-08, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources.
   5. RP-33-99, Recommended Practice for Lighting for Exterior Environments.
   6. TM-15-07 (Revised), Luminaire Classification System for Outdoor Luminaires.

D. International Electrotechnical Commission (IEC):
   1. IEC 60529 – Degrees of Protection provided by enclosures (IPCode).

E. National Electrical Manufacturers Association (NEMA):
   1. ANSI/NEMA/ANSLG C78.377-2008 – American National Standard for the Chromaticity of Solid State Lighting Products.

F. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code.

1.5 SITE LIGHTING SYSTEM PERFORMANCE

A. Light Loss Factors:
   1. Luminaire must operate for a minimum of 50,000 hours before the Lamp Lumen Depreciation (LLD) is 0.70 (L_{70}).
   2. Luminaire Dirt Depreciation (LDD) must be 0.90 or greater for all luminaires.

1.6 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1.7 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaires and accessories.
   3. Details of installation and construction.
   4. Luminaire materials.
   5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
      a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
      b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   6. Photoelectric relays.
   7. Ballasts, including energy-efficiency data.
   8. Drivers.
   9. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
   10. Materials, dimensions, and finishes of poles.
   11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
   12. Anchor bolts for poles.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

C. Performance Reports – Submit the following for approval:
   1. Luminaire photometric reports per IESNA LM-79-08 including: laboratory name, report number, date, luminaire catalog number, luminaire, and light source specifications. Report must contain lumen values in Backlight, Uplight, and Glare (BUG) zones per IESNA TM-15-07 and Roadway Type classifications, luminous Intensity, zonal lumen summary, and an iso-footcandle diagram per LM-31as well as documentation that specified standards and test methods were followed.
   2. Provide certification of one of the following:
      a. LM-79-08 report at T=0 and at T=6000 hours with a summary table showing the percent lumen output change and percent input power change.

b. LM-80-08 test data for the LEDs at the three temperatures per LM-80-08. Provide extrapolation data using an exponential decay function to show the output at 50,000 hours. Provide the Ts value from the LM-79-08 and where the point falls in relation to the LM-80-08 extrapolated data. Interpolate between the LM-80-08 data for the T_s temperature.

3. Provide safety certification and file number as required for the luminaire family that must be listed, labeled, or identified per the National Electric Code (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Power Supply Units: One for every 100 of each type and rating installed. Furnish at least one of each type. May be unitized with LEDs.

1.10 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for LEDs: Five year replacement material warranty for defective or non-starting LED source assemblies.
2. Warranty Period for Power Supply Units: Five year replacement material warranty for defective power supply units (PSUs).
3. Warranty Period for Light Sources: Five year replacement material warranty on all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor for the LEDs lumen maintenance not achieving L_{70} after 50,000 hours.
4. Warranty Period for Luminaires: Five years from date of Substantial Completion.
5. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
6. Warranty Period for Color Retention: Five years from date of Substantial Completion.
7. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

D. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

F. Exposed Hardware Material: Stainless steel.

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

H. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

I. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

K. Luminaire Finish: Manufacturer's paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

L. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: Finish as selected by Architect, from Architectural finishes color palette.

M. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2.3 LIGHT SOURCE REQUIREMENTS

A. LED sources must meet the following requirements:
   1. Operating temperature rating must be between -40°C and +50°C

2. Correlated Color Temperature (CCT):
   a. Nominal CCT: 3500 K (3465 ± 245)
   b. Nominal CCT: 4000 K (3985 ± 275)
   c. Nominal CCT: 4500 K (4503 ± 243)
   d. Nominal CCT: 5000 K (5028 ± 283)
   e. Du'v' tolerance of 0.001 ± 0.006
3. Color Rendering Index (CRI): greater than or equal to 65.
4. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
   a. High Temperature Operating Life (HTOL)
   b. Room Temperature Operating Life (RTOL)
   c. Low Temperature Operating Life (LTOL)
   d. Powered Temperature Cycle (PTMCL)
   e. Non-Operating Thermal Shock (TMSK)
   f. Mechanical Shock
   g. variable Vibration Frequency
   h. Solder Heat Resistance (SHR)

2.4 DRIVER REQUIREMENTS

A. LED drivers must meet the following requirements:
   1. Drivers must have a minimum efficiency of 85%.
   2. Starting Temperature: -40° C.
   3. Electrical Characteristics.
      a. Volts: Multi-voltage 120/277V.
      b. Phase: Single.
      c. Hertz: 60.
   4. Power supplies can be UL Class I or II output.
   5. Drivers must have a Power Factor (PF) of greater than or equal to 0.90.
   6. Drivers must have a Total Harmonic Distortion (THD) of greater than or equal to 20%.
   7. Drivers must comply with FCC 47 CFR Part 15 non-consumer RFI/EMI standards.
   8. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
   9. Drivers must comply with requirements in section 2.5 B Controls.

2.5 LUMINAIRE REQUIREMENTS

A. General Requirements:
   1. Electrical system cavity must be wet-location rated and be field accessible for service or repair needs.
   2. Optical cavity must be a minimum IEC 60529/IP65.
   3. The luminaire must have a luminaire efficacy greater than 40 LPW
   4. Fully assemble and electrically test luminaires before shipment from factory.
   5. Coating must be capable of surviving ASTM B117 Salt Fog environment for 500 hrs minimum without blistering of peeling. The coating must demonstrate gloss retention of greater than or equal to 90% for 500 Hrs exposure QUV test per ASTM G53 UVB313, 4 Hr UV-B 60 ˚C/4 hr Condensation 50 ˚C.
   6. Luminaire arm bolts must be type 304 stainless steel or zinc plated steel and Grade 8.
   7. Luminaires must have country appropriate governing mark and certification.
   8. Color of the luminaire housing is as noted in luminaire schedule.

B. Electrical System Requirements
   1. Surge protection devices: Listed for compliance with UL 1449.
   2. Endurance testing: Capable of protecting against and surviving 250 IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C transients without failure.
   3. Primary Fuse Protection: Provide Double Fusing with Fuse Holder appropriately sized to the current. Fuse voltage must be greater than or equal to line voltage Fuse holder to be easily accessible.
   4. Under voltage protection via shutoff and short circuit protection via current limitation.
   5. Internal luminaire design must include modular electrical connections.

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

2.7 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
   1. Shape: Square, tapered.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation.

B. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
   2. Match pole material and finish.

C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

E. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Painted Finish: Polyester powder coat.
   a. Color: Manufacturer's architectural finishes as selected by Architect.

2.8 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Section 262726 "Wiring Devices" for ground-fault circuit-interrupter type.
   1. Recessed, 12 inches (300 mm) above pole base.
   2. Reinforced fiberglass, weatherproof in use, that when mounted results in NEMA 250, Type 3R enclosure.
   3. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Minimum PRI 277V: SEC 120V, 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

B. Adjust luminaires that require field adjustment or aiming.[Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.]

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
   3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set poles using web fabric slings (not chain or cable).

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches (100 mm) above finished grade in landscape area at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 CORROSION PREVENTION

A. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.6 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of automatic controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 CLEANING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

3.8 EXTERIOR LUMINAIRE SCHEDULE

A. See drawings for Luminaire Schedule.

END OF SECTION

SECTION 266000
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Products and installation are as indicated in Division 26 Section “Raceway and Boxes for Electrical Systems."

1.2 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction including but not limited to receptacles, light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 CONDUIT SYSTEM

A. Provide 1" minimum from each outlet box location to an existing TR location.

B. Sleeves:

1. Floor penetrations: 2" minimum, unless noted otherwise.
2. Wall penetrations: 2" minimum, unless noted otherwise.

2.2 OUTLET BOXES

A. Minimum size: Two-gang.

B. Minimum depth:

1. 2-1/8" deep with single gang trim ring.
2. 3-1/2" deep masonry box.
3. 2-1/2" deep ganged box.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Indoors:

1. Exposed: PVC coated GRC.
2. Concealed: GRC.

B. Minimum Raceway Size: 1-inch trade size (DN 21).

3.2 INSTALLATION

A. Provide a raceway system with conduit routed continuously from outlet boxes to nearest accessible ceiling space, unless noted otherwise.

B. Ream conduit ends and bush conduit ends that do not terminate in an approved conduit fitting.

C. Sleeves:

1. Extend down to the top of backboards.
2. Extend down to 12 inches above racks in Telecom Rooms.

3.3 COORDINATION

A. Coordinate work and scheduling with Owner's Communications Cabling Systems contractors.

B. Support and anchor system's conduits to sustain weights encountered.

C. Verify cable sizing and weights with Communications Cabling contractors.

END OF SECTION

SECTION 283111
DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. System smoke detectors.
   2. Notification appliances.

B. Provide extension of the existing Siemens MXL-IQ Fire Alarm and Detection System. All new devices shall be manufactured by Siemens.

C. Provide installation of components for complete fire alarm systems, including detectors, notification appliance, signal equipment, controls and devices per the plans and as otherwise required by code/ordinance per the following specifications.

D. Extension of existing system as shown on the drawings and as specified herein.

E. Coordinate with the related work as specified elsewhere under the project specifications.

F. The Fire Alarm System shall consist of all necessary hardware equipment to perform the following functions:
   1. Fire Alarm and Detection Operations.

G. Include all provisions for complete conduit raceway system and wiring system.

1.2 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.3 SYSTEM DESCRIPTION

A. Extension of existing Siemens Fire Alarm / Detection System.

B. Non-coded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire alarm service only.

1.4 SUBMITTALS

A. General Submittal Requirements:
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
   2. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire alarm system design.
      b. NICET-certified fire alarm technician, Level IV minimum.
      c. Licensed or certified by authorities having jurisdiction.

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

C. Shop Drawings: For fire alarm system. Include plans, elevations, sections, details, and attachments to other work.
   1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire-alarm Systems" Chapter in NFPA 72.
   2. Include voltage drop calculations for notification appliance circuits.
   3. Include battery-size calculations.
   4. Include performance parameters and installation details for each detector.

5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

E. Qualification Data: For qualified Installer.

F. Field quality control reports.

G. Operation and Maintenance Data: For fire alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire alarm control unit.
7. Copy of NFPA 25.

H. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Software application and graphic screens

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire alarm Level IV technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire alarm system from single source from single manufacturer.

D. 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.

E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

1.6 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system, and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Siemens.

2.2 SYSTEM OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Record events in the system memory.

C. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire alarm control unit.
4. Ground or a single break in fire alarm control unit internal circuits.
5. Abnormal ac voltage at fire alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire alarm control unit or annunciator.

D. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire alarm control unit and remote annunciators. Record the event.

2.3 FIRE ALARM CONTROL PANELS

A. The fire alarm control panel is existing.

B. Install all additional power supplies, circuit cards, or other components necessary in the panel to accommodate the field devices shown on the drawings or as otherwise necessary for a complete installation.

C. All programming of the existing central panel Simplex under contract with Owner.

2.4 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:
   1. Comply with UL 268, operating at 24-V dc, nominal.
   2. Detectors shall be two-wire type.
   3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
   6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity by fire alarm control unit.
      a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F (8 or 11 deg C) per minute.
      b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F (57 or 68 deg C).
      c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

2.5 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760. Provide all fire alarm systems wiring within concealed listed metallic raceway. Raceways shall be factory prefinished RED, including all junction boxes and enclosures.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation within metallic raceway.
   1. Low-Voltage Circuits: No. 16 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire alarm equipment.

B. Equipment Mounting: Install fire alarm control unit on concrete base with tops of cabinets not more than 72 inches (1830 mm) above the finished floor. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
   1. Install seismic bracing. Comply with requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Smoke-or Heat-Detector Spacing:
1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed the rating of the detector.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

E. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler waterflow switch and valve-tamper switch that is not readily visible from normal viewing position.

F. Combination Speaker-Strobe Devices: Install not less than 6 inches (150 mm) below the ceiling. Install speakers on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

G. Visible Alarm-Indicating Devices: Install at least 80 inches (150 mm) above the finished floor, and no higher than 96” above the finished floor.

H. Device Location-Indicating Lights: Locate in public space near the device they monitor.

I. Fire-Alarm Control Unit/NAC Panels: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

J. Provide microelectronic monitor modules with 120V relays for each smoke damper connection to provide individual programmed control of damper(s).

K. Provide microelectronic monitor modules for Gas Leak Detection systems.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:
1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes." Conceal raceway except in unfinished spaces and as indicated. Install power limited fire-alarm circuits exposed in metallic raceways, or free-air cable methods supported by suitably rated cable hangers above finished ceilings and concealed within finished walls via conduit stubs and flush outlet boxes in finished areas.
1. Fire-alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable. All fire alarm system raceways shall be factory-prefinished in red or field painted by this Contractor. Cables and raceways used for fire-alarm circuits, and equipment control wiring associated with the fire-alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour fire-rated fire-alarm cables, per NFPA 70. Types MI and CI, are not permitted.
3. Signaling Line Circuits: Power-limited fire-alarm cables may be installed in the same cable or raceway as signaling line circuits.
4. Cable splices or terminations shall be made in listed fittings, boxes, enclosures, fire-alarm devices or utilization equipment.
5. All wall devices shall be installed with wiring through conduit stubs and flush backboxes.
6. Refer to NEC Article 760 for all wiring installation requirements.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes, covers and raceways red.

3.3 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated air-conditioning duct systems.
2. Alarm-initiating connection to activate emergency lighting control.
3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
4. Supervisory connections at valve supervisory switches.
5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire alarm control unit.

3.5 GROUNDING

A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.
   a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire-alarm Systems" Chapter.
   b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire-alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire-alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire alarm system.

END OF SECTION

SECTION 311000
SITE CLEARING

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. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion- and sedimentation-control measures.

B. Related Sections:

1. Section 015000 "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities**,** and temporary erosion- and sedimentation-control measures.
2. Section 017300 "Execution" for field engineering and surveying.
3. Section 017419 "Construction Waste Management and Disposal"
4. Section 024116 "Structure Demolition" for demolition of buildings, structures, and site improvements.
5. Section 024119 "Selective Structure Demolition" for partial demolition of buildings or structures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated differently on the drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Pre-installation Conference: Conduct conference at a location determined by the Architect, Engineer, Landscape Architect, or owner if requested.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: If applicable, authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Consultant.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify Diggers Hotline for area where Project is located before beginning earth moving operations.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

I. Soil stripping, handling, and stockpiling: Perform only when the topsoil is dry or slightly moist.

1.8 METHOD OF MEASUREMENT

A. Method of measurement will be lump sum.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Engineer or Landscape Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

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

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section 024116 "Structure Demolition" and Section 024119 "Selective Structure Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 4 inches or as indicated in the geotechnical report in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 312000
EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:

1. Section 033000 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
3. Section 312319 "Dewatering" for lowering and disposing of ground water during construction, if necessary.
4. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
5. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices or changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt wak.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Non-Detectable Warning Tape
4. Tracer Wire.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches.
2. Non-Detectable Warning Tape: 12 inches long; of each color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

A. Preexcavation Conference: Conduct conference at a location determined by the Architect, Engineer, Landscape Architect, or owner if requested.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: If applicable, authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Engineer.

C. Utility Locator Service: Notify Diggers Hotline for area where Project is located before beginning earth moving operations.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Section 015000 "Temporary Facilities and Controls," or Section 311000 "Site Clearing," are in place.

E. Do not commence earth moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487 or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand: ASTM D 448; course-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C 33; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
3. Sewn Seam Strength: 142 lbf; ASTM D 4632.

4. Tear Strength: 56 lbf; ASTM D 4533.
5. Puncture Strength: 56 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.5 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf; ASTM D 4632
3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
4. Tear Strength: 90 lbf; ASTM D 4533.
5. Puncture Strength: 90 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:

1. Portland Cement: ASTM C 150, Type I.
2. Fly Ash: ASTM C 618, Class C or F.
3. Normal-Weight Aggregate: ASTM C 33, 3/4-inch nominal maximum aggregate size.
4. Foaming Agent: ASTM C 869.
5. Water: ASTM C 94/C 94M.
6. Air-Entraining Admixture: ASTM C 260.

B. Produce low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: 30 to 36 lb/cu. ft. at point of placement, when tested according to ASTM C 138/C 138M.
2. Compressive Strength: 80 psi, when tested according to ASTM C 495.

C. Produce conventional-weight, controlled low-strength material with 80-psi compressive strength when tested according to ASTM C 495.

2.4 ACCESSORIES

A. General: Non-detectable warning tape shall be installed on all utility mainline systems, branches, and building service laterals, regardless of what type of pipe/wire they are constructed with. Tracer wire shall also be installed on utility mainline systems, branches, and building service laterals, but only when they are constructed with non-metallic pipe.

B. Non-Detectable Warning Tape: The tape shall be acid- and alkali-resistant, polyethylene file warning tape manufactured for marking and identifying underground utilities, a minimum of 3 inches wide and 4 mils thick. The tape shall be continuously inscribed with a description of the utility, and colored as follows:

1. Red: Electric.
2. Yellow: Gas, Oil, Steam, and Dangerous Materials.
3. Orange: Telephone, CATV Cable, Fiber Optic, and Other Communication Lines.

4. Blue: Water Systems.
5. Green: Sewer Systems.

C. Tracer Wire: The wire shall be a minimum of 10-guage solid wire with a solid PVC insulation coating suitable for underground installation. The wire shall be rated for wet conditions. The wire insulation color shall conform to the uniform color code adopted by the American National Standard Institute. Tracer wire shall be colored as follows:

1. Yellow: Gas, Oil, Steam, and Dangerous Materials.
2. Blue: Water Systems.
3. Green: Sewer Systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.8 SUBGRADE INSPECTION

A. Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices or changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."

D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."

E. CNG Gas Trenches: Provide sand gravel concrete mix backfill containing red dye no.8, 12 lbs. red dye colorant per yard concrete. Refer to details.

F. Backfill voids with satisfactory soil while removing shoring and bracing.

G. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

H. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

I. Place and compact final backfill of satisfactory soil to final subgrade elevation.

J. Controlled Low-Strength Material: Place final backfill or controlled low-strength material to final subgrade elevation.

K. Install non-detectable warning tape on all utility mainline systems, branches, and building service laterals, regardless of what type of pipe/wire they are constructed with. Alos install tracer wire on utility mainline systems, branches, and building service laterals, but only when they are constructed with non-metallic pipe.

1. Continuous underground non-detectable warning tape shall be installed along the enire length of all utilities during backfilling of trench. Locate tape directly above utility, 12-16 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

2. Tracer wire shall be installed along the entire length of all non-metallic pipe and taped on the top of the pipe at 10-foot intervals. The wire shall be located directly above and within 6 inches of the pipe at all times. Wire shall surface every 300 to 400 feet on the main line. Wire shall typically surface at hydrants, sewer structures, and lateral ends in a wire location box. An extra 18” of wire shall be provided at its termination point. Splices shall be held to a minimum. Where a splice is necessary, it shall be as shown in File No. 24B of the Standard Specifications. Conductivity of wire shall be tested prior to acceptance of pipe installation.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Section 334600 "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698
2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.
2. Shape subbase course and base course to required crown elevations and cross-slope grades.
3. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
4. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
5. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.20 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Engineer.

B. At project completion, remove surplus satisfactory soil, topsoil, and waste materials, including unsatisfactory soil, trash, and debris, from the project site and legally dispose of them off Owner's property.

END OF SECTION

SECTION 321216
ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. State Specifications - State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Latest Edition and Supplemental Specifications.

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Pavement-marking paint.

B. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of State of Wisconsin Department of Transportation.

1. Standard Specification: Standard Specifications for Highway and Structure Construction in Wisconsin, Latest Edition and Supplemental Specifications.
2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

B. Material Certificates: For each paving material, from manufacturer.

C. Material Test Reports: For each paving material.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the WDOT.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

i. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
ii. Review condition of subgrade and preparatory work.
iii. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
iv. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 deg F.
2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 ASPHALT MATERIALS

A. Provide Superpave Type E-1 pavement with PG 64-22 asphalt binder. The surface course shall utilize a 3/8-inch mix. The binder course shall utilize a 3/4-inch mix. Utilize the same material type throughout the paving operation. All materials provided under this section shall conform to the requirements of the Standard Specification, Section 407 and as revised in any current Supplemental Specifications.

B. Tack Coat: AASHTO M 140, emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Water: Potable.

2.2 AUXILIARY MATERIALS

A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.

1. Color: White

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

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

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.

3.7 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.8 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION

SECTION 321313
CONCRETE PAVING

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. Curbs and gutters.
2. Walks.
3. Pavement.

B. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

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

B. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Decorative Concrete Pavement: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.

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

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

E. ACI Publications: Comply with ACI 301 unless otherwise indicated.

F. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.

B. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.3 CONCRETE MATERIALS

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

1. Portland Cement: ASTM C 150, portland cement Type I
2. Fly Ash: ASTM C 618, Class C or F, or Ground Granulated Blast Furnace Slag (GGBFS), at a 1:1 ratio where freeze-thaw durability and exposure to deicers is likely; up to 350 pounds, at a minimum replacement of cementitious material for Portland cement of 25% and a maximum of 30%.

B. Normal-Weight Aggregates: ASTM C 33, Class 4M, uniformly graded. Provide aggregates from a single.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING AND SEALING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

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

C. Water: Potable.

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

E. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.5 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 4 inches plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.

1. Fly Ash: ASTM C 618, Class C or F, or Ground Granulated Blast Furnace Slag (GGBFS), at a 1:1 ratio where freeze-thaw durability and exposure to deicers is likely; up to 350 pounds, at a minimum replacement of cementitious material for Portland cement of 25% and a maximum of 30%.

2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

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

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.

3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

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

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies[, reinforcement,] or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture. Engineer or Owner to give final approval on texture selection prior to construction for all concrete surfaces.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

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

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   (1) Water.
   (2) Continuous water-fog spray.
   (3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
3. Curing Compound: Apply curing compound immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

   (1) Cure integrally colored decorative concrete with a curing compound.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 1/2 inch.

2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Joint Spacing: 3 inches.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

B. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

(1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

(1) A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 321373
CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Cold-applied joint sealants.
   2. Hot-applied joint sealants.

B. Related Sections:

   1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
   2. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
   3. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, Samples of materials that will contact or affect joint sealants.

   1. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit no fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint-preparation data that are based on previous testing, not older than 24 months, of sealant products for compatibility with and adhesion to joint substrates and other materials matching those submitted.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Pavement-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

D. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

F. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Engineer from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

i. Crafco Inc., an ERGON company; RoadSaver Silicone.
ii. Dow Corning Corporation; 888.
iii. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

i. Crafco Inc., an ERGON company; RoadSaver Silicone SL.
ii. Dow Corning Corporation; 890-SL.
iii. Pecora Corporation; 300 SL.

C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:

i. Pecora Corporation; Urexpan NR-200.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

i. Crafco Inc., an ERGON company; Superseal 444/777.

B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

i. Meadows, W. R., Inc.; Sealtight Hi-Spec.
ii. Right Pointe; D-3405 Hot Applied Sealant.

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

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

3.3 INSTALLATION OF JOINT SEALANTS

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

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

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:

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

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

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

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

3.5 PROTECTION

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

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.

1. Joint Location:

i. Expansion and isolation joints in cast-in-place concrete pavement.
ii. Contraction joints in cast-in-place concrete slabs.

iii. Other joints as indicated.

2. Silicone Joint Sealant for Concrete: Single component, nonsag.
3. Urethane Joint Sealant for Concrete: Multicomponent, pourable, traffic-grade.
4. Hot-Applied Joint Sealant for Concrete: Single component.
5. Joint-Sealant Color: As selected by Engineer from manufacturer's full range.

B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.

1. Joint Location:

i. Joints between concrete and asphalt pavement.
ii. Joints between concrete curbs and asphalt pavement.
iii. Other joints as indicated.

2. Hot-Applied Joint Sealant for Concrete and Asphalt: Single component.
3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range.

END OF SECTION

SECTION 323113
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Comply with Wisconsin Commercial Building Codes/International Building Code (IBC)

C. Comply with Americans with Disabilities Architectural Guidelines and ICC/ANSI A117.1-2003.

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.

B. Related Sections:

1. Division 03 Section “Cast-in-Place Concrete" for cast-in-place concrete post footings.
2. Division 31 Section “Earthwork Moving.”

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Chain-link fence shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7-05:

1. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:

a. Wind Loads: 85 mph
b. Exposure Category: B.
c. Fence Height: See plans.
d. Material Group: IA, ASTM F 1043, Schedule 40 steel pipe.

B. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures

B. Product Data: For each type of product indicated, include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

1. Fence posts, rails, and fittings.
2. Chain-link fabric, reinforcements, and attachments.
3. Accessories: Privacy Slats

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

D. Samples for Verification: Prepared on Samples of size indicated below:

1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.

E. Qualification Data: For qualified installer.

F. Product Certificates: For each type of chain-link fence and gate, signed by product manufacturer.

G. Product Test Reports: For framing strength according to ASTM F 1043.

H. Field quality-control reports.

I. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:

1. Polymer finishes.

J. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this project and whose work has resulted in construction with a record of successful in-service performance.

B. Testing Agency Qualifications: For testing fence grounding. An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association (NETA) or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Preinstallation Conference: Conduct conference at project site.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.7 WARRANTY

A. Special Warranty: The Installer agrees to repair or replace components of chain-link fences and gates that fail in parts, materials, or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire Fabric: Wire with a diameter of 0.192 inch.

a. Mesh Size: 2 inches
b. Aluminum-Coated Fabric: ASTM A 491, Type I, 0.40 oz./sq. ft.
c. Polymer-Coated Fabric (if indicated on plans): ASTM F 668, Class 2b over aluminum-coated steel wire.

i. Color: Black, complying with ASTM F 934.

d. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Knuckled at both selvages.

2.2 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:

1. Fence Height: As indicated on Drawings.

2. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40.

a. Line Post: 1.90 inch outside diameter, 2.72 lbs/ft.
b. Terminal and Corner Posts: 2.875 inch outside diameter, 5.79 lbs/ft.
c. Gate Post: 4.00 inch outside diameter, 9.10 lbs/ft.

3. Horizontal Framework Members: Top and bottom rails complying with ASTM F 1043.

a. Top Rail: 1.66 inch outside diameter, 2.27 lbs/ft.

b. Bottom Rail: 1.66 inch outside diameter, 2.27 lbs/ft.

4. Brace Rails: Comply with ASTM F 1043.
5. Metallic Coating for Steel Framing:

   a. Type A, consisting of not less than minimum 2.0-oz./sq. ft. average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating per ASTM A 653/A 653M.

6. Polymer coating over metallic coating (if indicated on plans).

   a. Color: Black, complying with ASTM F 934.

2.3 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post.

   1. Provide line post caps with loop to receive top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

   1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
   2. Rail Clamps: Line and corner boulevard clamps for connecting bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

   1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
      a. Aluminum: ASTM B 211; Alloy 1350-H19; 0.192-inch diameter, mill-finished wire.

I. Finish:

   1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc.

      a. Polymer coating over metallic coating (if indicated on plans)

   2. Aluminum: Mill finish.

2.4 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

2.5 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Aluminum.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 inch by 6 feet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earth moving, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts by mechanically driving into soil at indicated spacing into firm, undisturbed soil. Set every fourth line post, terminal post, corner post, and gate post in concrete.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Concealed Concrete: Top 2 inches to allow covering with surface material.

3. Mechanically Driven Posts: Drive into soil to depth of 36 inches. Protect post top to prevent distortion.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

D. Line Posts: Space line posts uniformly at 8 feet o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

G. Bottom Rails: Install and secure to posts with fittings.

H. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to top and bottom rails, and braces at 24 inches o.c.

K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

L. Privacy Slats: Install slats in direction indicated, securely locked in place.

1. Diagonally, for privacy factor of 80 to 85.

3.5 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1,500 feet, except as follows:

1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet .

a. Gates and Other Fence Openings: Ground fence on each side of opening.

i. Bond metal gates to gate posts.
ii. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.

E. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

F. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.6 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences.

END OF SECTION

SECTION 323119
DECORATIVE METAL FENCES AND GATES

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. Decorative aluminum fences.
   2. Swing gates.

B. Related Requirements:
   1. Division 03 Section "Cast-in-Place Concrete" for cast-in-place concrete footings.
   2. Division 31 Section "Earth Moving."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.

   1. Include diagrams for power, signal, and control wiring.

C. Samples: For each fence material and for each color specified.

   1. Provide Samples 12 inches in length for linear materials.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include 10-foot length of fence complying with requirements.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 DECORATIVE ALUMINUM FENCES

A. Decorative Aluminum Fences: Fences made from aluminum extrusions.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Alumi-Guard, Inc.
b. Ameristar Fence Products.
c. Carfaro, Inc.
d. Delair Group, L.L.C.
e. East & West Alum Craft Ltd.
f. Elegant Aluminum Products, Inc.
g. Elite Fence Products, Inc.
h. Ideal Aluminum Products.
i. Iron Eagle Industries, Inc.
j. Japra Group International.
k. Jerith Manufacturing Company, Inc.
l. Master Halco.
m. Merchants Metals.
n. Royal Aluminum and Steel, Inc.
o. Specrail.
p. Superior Aluminum Products, Inc.
q. Tek-Rail.
r. Ultra Aluminum Mfg., Inc.
s. Virginia Railing and Gates, LLC.

B. Posts: Square extruded tubes.

1. Line Posts: 2 by 2 inches with 0.062-inch wall thickness.
2. End and Corner Posts: 2 by 2 inches with 0.062-inch wall thickness.
3. Swing Gate Posts: 2-1/2 by 2-1/2 inches with wall thickness.

C. Post Caps: Aluminum castings that cover entire top of posts.

D. Rails: Extruded-aluminum channels, 1 by 1 inch with 0.080-inch- thick sidewalls and 0.055-inch- thick top.

E. Pickets: Extruded-aluminum tubes, 5/8 inch square, with 0.050-inch wall thickness.

1. Terminate tops of pickets at top rail for flush top appearance
2. Picket Spacing: 4 inches clear, maximum.

F. Fasteners: Manufacturer's standard concealed fastening system.

G. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

H. Fabrication: Assemble fences into sections by fastening pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.
2. Drill clips for fasteners before finishing.

I. Finish exposed welds to comply with NOMMA Guideline 1, Finish #3 - partially dressed weld with splatter removed.

J. Finish: Baked enamel or powder coating.

2.3 SWING GATES

A. Gate Configuration: Double leaf.

B. Gate Frame Height: 36 inches.

C. Gate Opening Width: 48 inches each leaf.

D. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes 2 by 2 inches with 0.125-inch wall thickness.

E. Frame Corner Construction: Welded.

F. Infill: Comply with requirements for adjacent fence.

G. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

H. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates.

I. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

J. Rim Locks: BHMA A156.5, Grade 1, suitable for exterior use.

1. Function: 621 - Latchbolt by key from outside and by turn from inside. Latchbolt is held retracted by device from inside.
2. Material: Cast, forged, or extruded brass or bronze.

3. Mounting Plate: Configuration necessary for mounting locks. Fabricate from 1/8-inch-aluminum plate.

K. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push pad actuating bar, suitable for exterior use.

1. Function: Exit only, no trim or blank escutcheon
2. Mounting Channel: Bent-plate channel formed from 1/8-inch- aluminum plate. Channel spans gate frame. Exit device is mounted on channel web, recessed between flanges, with flanges extending 1/8 inch beyond push pad surface.

L. Finish exposed welds to comply with NOMMA Guideline 1, Finish #3 - partially dressed weld with splatter removed.

M. Aluminum Finish: Baked enamel or powder coating.

2.4 ALUMINUM

A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.

B. Extrusions: ASTM B 221, Alloy 6063-T5.

C. Tubing: ASTM B 429/B 429M, Alloy 6063-T6.

D. Plate and Sheet: ASTM B 209, Alloy 6061-T6.

E. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.

F. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.5 MISCELLANEOUS MATERIALS

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

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

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

2.6 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic-welded type.
2. Grounding Rods: Copper-clad steel.

a. Size: 5/8 by 96 inches.

2.7 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: Flat Black.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post.
    b. Concealed Concrete: Top 2 inches below grade to allow covering with surface material. Slope top surface of concrete to drain water away from post.

3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.

    a. Extend posts at least 5 inches into sleeve.
    b. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.

5. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch larger than outside diagonal dimension of post.

    a. Extend posts at least 5 inches into concrete.
    b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.
6. Space posts uniformly at 6 feet o.c.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:

1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.

    a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports of grounding resistance at each test location certified by a testing agency. Include observations of weather and other phenomena that may affect test results.

3.7 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.8 DEMONSTRATION

A. Train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION

SECTION 329200
TURF AND GRASSES

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. Seeding.
2. Hydroseeding.
3. Turf renovation.
4. Bio-retention basin seeding.
5. Erosion-control material(s).

B. Related Sections:

1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
3. Division 32 Section "Plants" for border edgings and bio-retention basin construction.
4. Division 33 Section "Subdrainage" for subsurface drainage.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

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

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass, prairie grass, and sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For soil amendments and fertilizers, from manufacturer.

D. Material Test Reports: For imported or manufactured topsoil.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and prairie grass during a calendar year. Submit before expiration of required initial maintenance periods with copy to Landscape Architect.

F. Proof of adequate liability insurance (certificates of insurance coverage shall be provided) covering the work being done.

G. A detailed plan of work components, operations, and schedules shall be developed and submitted for approval to the DPRC's Natural Areas Coordinator a minimum of 10 work days prior to the planned construction start date. A restoration plan must include the following:

1. An inventory of baseline site conditions, which shall include GPS/GIS generated maps detailing the location of invasive non-native flora and fauna (specie specific maps), sensitive natural areas (wetlands or areas of high bio-diversity), and locations of any human use trails (hard & soft).
2. A detailed plan addressing the management of the above mapped non-native or invasive species and the protection of any identifies sensitive natural resource areas during the project timeframe.
3. A detailed bi-weekly restoration timeline explaining methods and procedures.
4. A detailed monthly maintenance plan for the contracted project timeframe. Even though this deals with the timeframe after the restoration is complete, it must be done prior to the start of any site work.

5. List of plant material (seeds, plugs, trees, shrubs, etc.) to be planted, vendor used, and the place of origin (i.e. the source of seed or plant materials), planting dates, planting methods, and seeding/planting rates.
6. Maps: topographical, soils, navigable waterways, WDNR approved wetlands maps, etc.
7. Contact information for the restoration contractor's project supervisor (must include cell phone number and email address).
8. All applicable local, state, and federally required permits are the responsibility of the contractor to have on site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer who has completed landscaping work of similar scope, material, and design to the extent indicated for this project and whose work has resulted in successful establishment of plants.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

2. Contractors/subcontractors: Requires a proven track record supported with references that clearly demonstrate level of experience planning, designing, and/or conducting natural resources restoration projects in southeast Wisconsin.

3. Pesticide Applicator: State licensed, commercial.

B. Source Quality Control: Ship materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.

C. Analysis and Standards: Package standard products with manufacturers certified analysis. For other materials, provide analysis by recognized laboratory, whenever applicable.

D. Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, utilizing methods established by the Association of Official Agricultural Chemists, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

E. Substitutions: If specified landscape material is not obtainable, submit non-availability to Landscape Architect together with proposal for use of equivalent material. When authorized, adjustment of contract amount will be made.

F. Preinstallation Conference: Conduct conference at Project site if requested by Architect or Landscape Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable. Protect materials from deterioration during delivery and while stored at site. Store seed in a waterproof container.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

A. Proceed with and landscape work as site becomes available, working within seasonal limitations for each kind landscape work and adjusting schedule to achieve optimum results.

B. Planting Restrictions: Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Seed: Planting may begin after frost has receded from the site until mid-October. If seed is planted after mid-October, Contractor assumes responsibility for the establishment of acceptable planting growth in spring and will provide labor and materials as necessary at no additional charge to owner to do so.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

D. Utilities: Determine location of underground utilities and perform work to avoid possible damage. Hand excavate as required at no additional cost to owner.

E. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Architect, Construction Manager, Owner, or Owner’s representative no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Architect's, Construction Manager's, Owner’s, or Owner’s Representative’s written permission.

F. Contractor Coordination: Wherever any part of landscape work is executed in conjunction with other project construction, it shall be the responsibility of this Contractor to coordinate with other concerned parties.

1.8 MAINTENANCE SERVICE

A. Initial Seed Mix Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable plantings are established but for not less than the following periods:

1. Seed mix areas: 60 days from date of planting completion.

a. When initial maintenance period has not elapsed before end of planting season, or if seed mixes are not fully established, continue maintenance during next planting season.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 SEED

A. Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows:

C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.

2. Sun and Partial Shade: Proportioned by weight as follows:
   a. 50 percent Kentucky bluegrass (Poa pratensis).
   b. 30 percent chewing red fescue (Festuca rubra variety).
   c. 10 percent perennial ryegrass (Lolium perenne).
   d. 10 percent redtop (Agrostis alba).

3. Shade: Proportional by weight as follows:
   a. 50 percent chewing red fescue (Festuca rubra variety).
   b. 35 percent rough bluegrass (Poa trivialis).
   c. 15 percent redtop (Agrostis alba).

4. No Mow Fescue Seed Mix: Fresh, clean, and dry new seed, of mixed species as follows:
   a. “No Mow Lawn Mix with Annual Rye Nursery Crop” from Prairie Nursery, Inc. P.O. Box 306, Westfield, WI 53964. (800) 476-9453, or equivalent product with approval from Architect or Landscape Architect.

5. Bioretention Seed Mix: Fresh, clean, and dry new seed, of mixed species as follows:
   a. “Infiltration Seed Mix” from Agrecol, LLC. 10101 North Casey Road Evansville, WI 53536 (608) 223-3571, or equivalent product with approval from Architect or Landscape Architect.

2.2 INORGANIC SOIL AMENDMENTS

A. Provide the following as necessary per soil analysis and/or specified for planting soils.

B. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class O, with a minimum 95 percent passing through a No. 8 sieve and a minimum 55 percent passing through No. 60 sieve.

C. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 6 to 7.5.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.4 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.5 PLANTING SOILS

A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

B. Planting Soil: Existing, in-place surface soil or on-site stockpiled native surface topsoil formed under natural conditions with the duff layer retained during excavation process. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Supplement with another specified planting soil when quantities are insufficient.

C. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.6 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.7 HERBICIDES

A. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

B. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.8 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.9 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd, with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

D. Proprietary Growing Mix: As submitted and acceptable to Landscape Architect.

E. ALL erosion control material that has a nylon-based component must have snake exclusion fencing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 SEED MIX AREA PREPARATION

A. Limit seed mix subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread planting soil to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 2 inches of soil
b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If seed mix is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 2 inches of soil. Till soil to a homogeneous mixture of fine texture.
3. Remove stones larger than 2 inches in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Seed Mix Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft per manufacturer’s specifications.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch if requested within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with manufacturer's recommended tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.7 SEED MIX MAINTENANCE

A. Maintain and establish seed mix by watering, fertilizing, weeding, replanting, and performing other operations as required to establish healthy, viable native and naturalized habitat. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and grasses/prairie plantings damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep seed mix plantings and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, and hoses to convey water from sources and to keep seed mix uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water seed mix with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Seed Mix Postfertilization: Apply fertilizer after seed mix has established growth and when plantings are dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to seed mix areas.

3.8 SATISFACTORY SEED MIX PLANTINGS

A. Seed mix installations shall meet the following criteria as determined by Landscape Architect:

1. Satisfactory seed mix/ native restoration areas: At end of maintenance period, a healthy, uniform, close stand of prairie plantings has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Damage resulting from erosion (gulleys, washouts) or other causes shall be repaired by Contractor in accordance with original installation at Contractors expense if damage occurs before Owner's acceptance.

B. Use specified materials to reestablish seed mix/native restoration areas that does not comply with requirements and continue maintenance until native restoration areas is satisfactory.

3.9 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by site landscape work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 329300
PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bio-retention Basin
   2. Warranties
   3. Maintenance

B. Related Sections:
   1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
   2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
   3. Division 32 Section "Turf and Grasses" for turf (lawn) and bio-retention planting, hydroseeding, and erosion-control materials.
   4. Division 33 Section "Subdrainage" for subsurface drainage.

1.2 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

D. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

E. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

I. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

P. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

Q. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, including soils..
   1. Pesticides, Herbicides, Fertilizers, and Anti-Dessicants: Include product label and manufacturer's application instructions specific to the Project.

B. Samples for Verification: For each of the following:
   1. Engineered Soil: Quart container or plastic bag with manufacturer’s name and specifications.
   2. Geotextile Filter Fabric: 12 by 12 inches with manufacturer’s specifications.
   3. Pond Liner: 12 by 12 inches with manufacturer’s specifications.

C. Photos for Verification: Provide photos or video for each of the following:
   1. Provide photos of excavation and installation through out the construction process of all underground components of the bio-retention area, including but not limited to excavation, sand layer installation, filter fabric installation, underground piping, cleanout, and structure installation, stone installation, filter fabric encasement, and engineered soil installation.

D. Product Certificates: For fertilizers, signed by product manufacturer:

E. Material Test Reports: For imported or manufactured topsoil.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plant material and other landscape work during a calendar year. Submit before expiration of required initial maintenance periods with copy to Landscape Architect.

G. Warranty: Provide in writing to owner, warranty with dates and coverage upon final completion.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer who has completed landscaping work of similar scope, material, and design to the extent indicated for this project and whose work has resulted in successful establishment of plants.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

   2. Pesticide Applicator: State licensed, commercial.

B. Source Quality Control: Ship materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.

C. Analysis and Standards: Package standard products with manufacturers certified analysis. For other materials, provide analysis by recognized laboratory, whenever applicable.

D. Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, utilizing methods established by the Association of Official Agricultural Chemists, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

E. Preinstallation Conference: Conduct conference at Project site if requested.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.6 PROJECT CONDITIONS

A. Proceed with landscape work as site or portions of site becomes available, working within seasonal limitations for each kind landscape work and adjusting schedule to achieve optimum results.

B. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Planting Completion. Notify Architect or Landscape Architect of planting completion date.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

D. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

E. Utilities: Determine location of underground utilities and perform work to avoid possible damage. Hand excavate as required at no additional cost to owner.

F. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Architect, Construction Manager, Owner, or Owner’s representative no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Architect's, Construction Manager's, Owner’s, or Owner’s Representative’s written permission.

G. Contractor Coordination: Wherever any part of landscape work is executed in conjunction with other project construction, it shall be the responsibility of the Landscape Contractor to coordinate with other concerned parties.

H. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.7 WARRANTY

A. Refer to 32 92 00 Turf and Grasses

1.8 MAINTENANCE SERVICE

A. Refer to 32 92 00 Turf and Grasses

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. Refer to 32 92 00 Turf and Grasses

2.2 INORGANIC SOIL AMENDMENTS

A. Provide the following as necessary per soil analysis and/or specified for planting soils.

B. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Class O, with a minimum 95 percent passing through a No. 8 sieve and a minimum 55 percent passing through No. 60 sieve.

C. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials. Sand for the engineered soil and interface layer to be either USDA Course Sand (.02 - .04 inches) or conform to ASTM C33 (Fine aggregate Concrete Sand). The sand component shall consist of mineral sand that is 97% SiO2. Sand to be washed to remove clay and silt particles and be well-drained prior to mixing or installation.

H. Engineered Soil Sand: Sand for the engineered soil and interface layer to be either USDA Course Sand (.02 - .04 inches) or conform to ASTM C33 (Fine aggregate Concrete Sand). The sand component shall consist of dolomitic sand. Sand to be washed to remove clay and silt particles and be well-drained prior to mixing or installation.

I. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

J. Infiltration Pea Gravel: Pea gravel in bio-retention basin shall be washed; free of loam, sand, clay, and other foreign substances and large enough to prevent it's falling through the perforations in the underground pipe.

K. Infiltration Gravel: Gravel in bio-retention basin shall be double washed, free of loam, sand, clay, and other foreign substances, and meet the course aggregate #2 and other specifications of the Wisconsin Standards and Specifications for Highway and Structure Construction, Section 501.2.5, 2003 edition or equivalent approved by administering authority.

L. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

   1. Organic Matter Content: 50 to 60 percent of dry weight.

2. Compost shall meet the requirements of Wisconsin Department of Natural Resources Specifications S100 Compost.

B. Leaf Compost: LeafGro 100% leaf compost from White Oak Farms.

C. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 6 to 7.5.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

E. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

F. Super phosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

G. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

H. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.4 PLANTING SOILS

A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

B. Planting Soil: Existing, in-place surface soil or on-site stockpiled native surface topsoil formed under natural conditions with the duff layer retained during excavation process. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Supplement with another specified planting soil when quantities are insufficient.

C. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

D. Engineered Soil: Planting mixture consisting of sand and compost in a ratio of 70% dolomitic sand and 30% compost. Engineered soils to have adequate nutrient content to support plant growth, have a ph range of 5.5 to 6.5, be free of rocks, stumps, roots, brush, or other material over 1 inch in diameter, and contain no other materials that may be harmful to plant growth or prove a hindrance to planting or maintenance. Refer to drawings for additional information.

2.5 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.6 MISCELLANEOUS PRODUCTS

A. Geotextile Filter Fabric: To meet the specifications of Wisconsin Standards and Specifications for Highway and Structure Construction, Section 645.2.4, Schedule Test B, 2003 edition or equivalent approved by administering authority. To be needle punched Geotex 451 brand or equivalent.

B. Pond Liner: To be 45 mil EPDM unless otherwise specified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine landscape areas for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 PLANTING AREA ESTABLISHMENT

A. Refer to 32 92 00 Turf and Grasses

3.4 EXCAVATION FOR RAINGARDEN (Bio-retention Facility)

A. Construction Methods shall follow Wisconsin Department of Natural Resources Conservation Practice Standard 1004 for “Bioretention For Infiltration,” except hereinafter modified

B. In bio-retention basin area, excavate as directed on plans and details for installation of underground piping system, gravel, geotextiles, and engineered soils. Legally dispose of excess material off Owner's property.

C. Maintain supervision of excavations during working hours. Keep excavations covered or otherwise protected when unattended by CONTRACTOR’S personnel. Do not over excavate.

D. Minimize compaction of bio-retention basin base and fill soil. If compaction has occurred, alleviate by using a chisel plow, ripper, or subsoiler to refracture the soil profile through the 12” compaction zone.

E. After compaction has been rectified or if no compaction has occurred, rototill the sand interface layer into the base of the bio-retention basin area to a depth of 2”-4”. Then install gravels, perforated pipe, drain basins, overflow pipes and geotextile filter fabric. Install engineered soil mix as specified on plans and details in 8”-12” lifts to meet final grades after natural settlement. Do not compact engineered soils during installation. Photograph process as directed under submittal process.

F. Lightly watering lifts to promote natural settlement is permitted if the lift is allowed to dry before adding the next lift. Ideally, allow bio-retention basin to settle naturally over several months before planting and adjust grade with additional engineered soil if necessary. Do not install if engineered soils if subgrade is frozen, muddy, or excessively wet.

3.5 PLANTING IN RAINGARDEN (Bio-retention Facility)

A. Refer to 32 92 00 Turf and Grasses for seed mix planting instructions.

B. Grade planting areas and engineered soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll non-engineered soils only, rake, remove ridges, and fill depressions to meet finish grades after settling.

3.6 POND LINER INSTALLATION

A. Install pond liner per manufacturers' specifications. Protect underside from puncture by installing a geotextile fabric prior to pond liner installation. If installing stone or other material that may puncture the liner on top of liner, install a geotextile fabric on top of liner.

3.7 PLANT MAINTENANCE

A. Refer to 32 92 00 Turf and Grasses

3.8 BIO-RETENTION BASIN OPERATIONS & MAINTENANCE

A. Maintain bio-retention basin plant material by watering through the first growing season and during dry periods there-after as necessary. Inspect, treat, or replace diseased plant material as necessary but no less than twice per year.

B. Inspect bio-retention basin for weed germination twice per month. Remove weed growth, preferably including roots.

C. As bio-retention basin matures, crowding may occur with perennial and groundcover plant material. Divide and remove as necessary during the spring.

D. Inspect for and repair soil erosion monthly. If excessive erosion is occurring, reevaluate design and repair accordingly.

E. Remove litter and debris monthly, especially during spring and fall.

F. Inspect for sediment build-up and clogging of infiltration system annually. Rejuvenation of bio-retention basin may be required, up to and including removal and reinstallation of new soils, gravels, filter fabric, and plants, typically 10-15 years from installation.

G. Inspect and clean all storm water structures, catch basins, manholes, pipe, etc. twice per year.

H. Test soil for pollutants every 5 years, especially when metal accumulation is suspected to be present. Replace when levels become toxic or begin to impair plant growth.

I. Prevent piling and storage of snow in bio-retention basin area.

3.9 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.10 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and project site.

3.11 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION

SECTION 334100
STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. All work performed and materials supplied shall conform to the Standard Specifications for Sewer and Water Construction in Wisconsin, latest edition, herein referred to as the Standard Specifications, unless otherwise called for in these specifications.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Drains.
4. Manholes.
5. Catch basins.
6. Stormwater inlets.
7. Stormwater detention structures.

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins: Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

C. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle catch basins according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. All sewer pipe and fittings shall conform to Part VIII of the Standard Specification for Sewer and Water Construction in Wisconsin, latest edition, unless otherwise called for in these specifications.

2.2 PVC PIPE AND FITTINGS

A. PVC Pipe: All PVC sewer pipe and fittings shall conform to Chapter 8.10.0 of the Standard Specifications.

2.3 MANHOLES

A. Standard Precast Concrete Manholes:

1. All manholes shall conform Chapter 3.5.0 of the Standard Specification for Sewer and Water Construction in Wisconsin, latest edition.
2. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
3. Diameter: 48 inches minimum unless otherwise indicated on the plans.
4. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
5. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
6. Riser Sections: 4-inch minimum thickness and lengths to provide depth indicated.
7. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
8. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
9. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
10. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 48 inches.
11. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

12. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Precast Concrete Manholes:

1. All manholes shall conform Chapter 3.5.0 of the Standard Specification for Sewer and Water Construction in Wisconsin, latest edition.
2. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
3. Diameter: 48 inches minimum unless otherwise indicated on the plans.
4. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
5. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.

8. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, material, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 48 inches.
9. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.

C. Manhole Frames and Covers:

1. All manhole frames and covers shall conform Chapter 8.48.0 of the Standard Specification for Sewer and Water Construction in Wisconsin, latest edition, or as shown on the Plans.

2.4 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
8. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 48 inches.
9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch diameter frame and grate.
4. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 48 inches.
5. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

D. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.5 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, and of materials and dimensions according to the Site Utility Plan.

B. Gutter Inlets: Made with horizontal gutter opening, and of materials and dimensions according to the Site Utility Plan. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings, and of materials and dimensions according to the Site Utility Plan. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty and according to the Site Utility Plan.

2.6 STORMWATER DETENTION STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Ballast: Increase thickness of concrete as required to prevent flotation.
2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch diameter frame and cover.
3. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 16-inch intervals. Omit steps if total depth from floor of structure to finished grade is less than 48 inches.

B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.

2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with 24-inch minimum cover.
4. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
5. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
6. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
2. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
4. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
5. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 DRAIN INSTALLATION

A. Install type of drains in locations indicated. Refer to site utility plan and site details.

1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in roads.

B. Embed drains in 4-inch minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in 4-inch minimum concrete around bottom and sides. Refer to site details and manufacturers specifications.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.9 CONNECTIONS

A. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

    a. Shielded flexible couplings for same or minor difference OD pipes.
    b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.10 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: All abandoned underground piping shall be removed.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and remove all remaining piping.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.11 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping according to ASTM F 1417.
    c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.13 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION

SECTION 334600
SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes subdrainage systems for the following:

1. Bio-Retention Facility

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. HDPE: High-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

E. PS: Polystyrene plastic.

F. PVC: Polyvinyl chloride plastic.

G. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Perforated-wall pipe and fittings.
2. Solid-wall pipe and fittings.
3. Drainage conduits.
4. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to the "Piping Applications" Article in Part 3 for applications of pipe, tube, fitting, and joining materials.

2.2 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 nd Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

2.3 SOLID-WALL PIPES AND FITTINGS

A. ABS Sewer Pipe and Fittings: ASTM D 2751.

1. Solvent Cement: ASTM D 2235.
2. Gaskets: ASTM F 477, elastomeric seal.

B. PE Drainage Tubing and Fittings: AASHTO M 252, Type S, corrugated, with smooth waterway, for coupled joints.

1. Couplings: AASHTO M 252, corrugated, band type, matching tubing and fittings.

C. PE Pipe and Fittings: AASHTO M 294, Type S, corrugated, with smooth waterway, for coupled joints.

1. Couplings: AASHTO M 294, corrugated, band type, matching tubing and fittings.

D. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.

1. Gaskets: ASTM F 477, elastomeric seal.

2.4 SPECIAL PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.

1. Sleeve Materials:
   a. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

2.5 CLEANOUTS

A. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

2.6 SOIL MATERIALS

A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

2.7 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

1. Structure Type: Nonwoven, needle-punched continuous filament.
2. Style(s): Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

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

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 PIPING APPLICATIONS

A. Underground Subdrainage Piping:

1. Perforated PE pipe and fittings, couplings, and coupled joints.

B. Header Piping:

1. ABS pipe and fittings, gaskets, and gasketed joints.
2. PE drainage tubing and fittings, couplings, and coupled joints.

3.4 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:

1. At Grade in Earth: PVC cleanouts.
2. At Grade in Paved Areas: Cast-iron cleanouts.

3.5 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.

B. Place impervious fill on subgrade adjacent to bottom of footing and compact to dimensions indicated, but not less than 6 inches deep and 12 inches wide after concrete footing forms have been removed.

C. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

D. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

E. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

F. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

G. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

H. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

I. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

J. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

K. Place initial backfill material over compacted drainage course . Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.6 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
2. Lay perforated pipe with perforations down.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install ABS piping according to ASTM D 2321.

D. Install PE piping according to ASTM D 2321.

E. Install PVC piping according to ASTM D 2321.

3.7 PIPE JOINT CONSTRUCTION

A. Join ABS pipe and fittings according to ASTM D 2751.

B. Join PE pipe, tubing, and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties."

C. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.

D. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

E. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

F. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.8 CLEANOUT INSTALLATION

A. Cleanouts for Foundation Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
3. In nonvehicular-traffic areas, use NPS 4 [cast-iron] [PVC] pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches in depth. Set top of cleanout plug 1 inch above grade.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

3.10 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION

SECTION 334713
POND & RESERVOIR LINERS

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 geomembrane liners for ponds and reservoirs.

B. Related Sections:
   1. Division 31 Section "Earth Moving" for excavating, compacting, and grading the subgrade; for excavating and backfilling the anchor trench; for protecting the earthwork; for adding requirements for the earth cover; and for the filter fabric and other geotextiles.

1.3 DEFINITIONS

A. Plastics Terminology: See ASTM D 1600 for definitions of abbreviated terms for plastics not otherwise defined in this Section.

B. EPDM: Ethylene-propylene-diene terpolymer.

1.4 PERFORMANCE REQUIREMENTS

A. Provide geomembrane liners that prevent the passage of water.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

   1. Sheets for geomembrane liners.
   2. Seaming adhesives, solvents, and extrusions.
   3. Penetration assemblies.
   4. Accessories for floating covers.

B. Shop Drawings: Show fabrication and installation details for geomembrane liners. Show panel layout, seams, penetrations, perimeter anchorage, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.

C. Samples: For the following products, in sizes indicated:

   1. Geomembrane Panels: For each type, not less than one 12-inch seam length for factory-bonded sheets and one 12-inch seam length for field-bonded sheets.

D. Qualification Data: For qualified installer.

E. Product Certificates: For each type of geomembrane liner, from manufacturer.

F. Product Test Reports: For each geomembrane sheet, based on evaluation of comprehensive tests performed by a qualified testing agency.

G. Source quality-control reports.

H. Field quality-control reports.

I. Maintenance Data: For geomembrane liner to include in maintenance manuals.

J. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain geomembrane liner, accessories, and required seaming materials, solvents, and adhesives from single source.

C. Preinstallation Conference: Conduct conference at Project site.

1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
2. Review structural load limitations.
3. Review limitations on equipment and Installer's personnel.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
5. Review required testing, inspecting, and certifying procedures.
6. Review existing and forecasted weather conditions and procedures for unfavorable conditions.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit placement and seaming of geomembrane liners to be performed according to manufacturers' written instructions and warranty requirements.

1.8 WARRANTY

A. Special Warranty: Specified form in which geomembrane manufacturer, geomembrane liner fabricator, and geomembrane liner Installer agree to repair or replace geomembrane liner that fail(s) in materials or workmanship or that deteriorate(s) under conditions of normal weather within specified warranty period. Warranty does not include deterioration or failure of geomembrane liner due to exposure to harmful chemicals, gases or vapors, abnormal and severe weather phenomena, fire, earthquakes, floods, vandalism, or abuse by persons, animals, or equipment.

1. Failures include, but are not limited to, the following:

   a. Leaks in geomembrane liner.
   b. Defects in seams.

2. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EPDM SHEET MATERIALS

A. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible sheets.

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

   a. Firestone Building Products.
   b. Integra Plastics, Inc.
   c. Yunker Plastics, Inc.

2. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

   a. Construction: 9 x 9 - 1000 d.

3. Nominal Thickness: 45-mil thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
4. Breaking Strength: Not less than 190 lbf minimum average per ASTM D 882, ASTM D 7004, or ASTM D 751, Procedure A.
5. Tear Resistance: Not less than 130 lb minimum average per ASTM D 1004.
6. Puncture Strength: Not less than 60 lbf minimum average per ASTM D 4833.

2.2 MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.

B. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.

C. Battens: Long-length strips of material indicated, size as shown on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.

1. Batten Material: Liner manufacturer's standard system.
2. Batten Material: Aluminum; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
3. Batten Material: Stainless steel; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
4. Batten Material: Plastic compatible with geomembrane liner, cast in place or fastened with stainless-steel anchors, designed to continuously seal geomembrane liner to batten.

D. Sand: ASTM C 33; fine aggregate, natural or manufactured sand.

2.3 FABRICATION

A. Fabricate geomembrane liner panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

B. Fabricate flotation blocks, wrap in geomembrane, and attach to underside of floating cover according to manufacturer's written instructions.

C. Fabricate ballast tubes of sand-filled geomembrane and attach to top surface of floating cover according to manufacturer's written instructions.

D. Install built-in accessories, hatches, access panels, vents, and walkways on geomembrane floating cover.

2.4 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate geomembrane seams.

B. Destructive Testing: Test for bonded seam strength and peel adhesion every 3000 feet or once per panel, whichever is more frequent.

C. PVC Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. of seam width and for bonded seam strength not less than that indicated below for seams constructed from two sheets of minimum nominal thickness indicated for each:
   1. Width.
   2. Bonded Seam Strength for 60-mil- Thick Sheets: 116 lbf/in. of seam width.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.

B. Examine anchor concrete perimeter, where geomembrane liner will be secured, for substrate conditions indicated above and for correct location and configuration.

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

3.2 PREPARATION

A. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.

B. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.

C. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

3.3 INSTALLATION

A. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.

B. Field Seams: Comply with geomembrane liner manufacturer's written instructions. Form seams by lapping edges of panels 2 to 4 inches unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.

1. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.
2. Thermal Bonding: Use thermal-welding technique recommended by geomembrane liner manufacturer. Apply pressure to smoothly bond surfaces together. Examine for and patch wrinkles and fishmouths.

C. Attachment to Concrete: Use manufacturer's standard system to suit Project conditions. Support adhesive and geomembrane on minimum 8-inch- wide concrete substrate unless otherwise indicated.

1. Install batten strips over geomembrane liner as shown on Drawings.
2. Install antichafing strips of geomembrane sheet between geomembrane liner and floating cover according to manufacturer's written instructions.
3. Install floating cover with perimeter fold.

D. Floating Cover Flotation Control: Connect drainage hoses in perimeter fold, sumps, or scuppers to pump or gravity drain system.

E. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D 4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.

C. Prepare test and inspection reports.

3.5 DISINFECTION

A. Disinfect the complete installation according to procedures in AWWA C652.

3.6 PROTECTION

A. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane and seams and reinspect repaired work.

END OF SECTION

SECTION 400100
CNG FUELING SYSTEM EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. This specification covers installation of compressed natural gas (CNG) fueling system equipment (furnished by others) by others for the City of Milwaukee Northwest Garage at 3025 West Ruby Avenue, Milwaukee, Wisconsin, 53209.

B. All references to equipment and materials either furnished by or provided by ANGI is to be interpreted as being the basis of design and not sole source specified. Engineer and Owner preapproved equivalent products will be accepted, see Section 016210 for substitute requests. Basis of design for all equipment in this Section is the following:

1. ANGI Energy Systems, Inc. (ANGI), 15 Plumb Street, Milton, WI 53563, 800-955-4626, Dan Hicks, DHicks@angienercy.com, www.angiinternational.com
2. AssetWorks, 998 Old Eagle School Road, Wayne, PA 19087, Joseph A. Basile, VP Fueling Technologies, Joseph.basile@assetworks.com, 610-228-0120, and Jill Coffin, Jill.Coffin@assetworks.com, 610-228-0126.

C. CNG fueling system equipment furnished by ANGI shall consist of the following components and services:

1. Tag Nos. 02-CMP-02 Twin Gas Compressor in enclosure
2. Tag Nos. 02-TK-04 thru -06 CNG storage Vessels
3. Tag Nos. 02-FD-03 CNG Fast-Fill Dispensers
4. Tag Nos. 1 Single Time-Fill Hose Post Assembly
5. Tag Nos. 2 thru 8 Dual Time-Fill Hose Post Assemblies
6. Tag No. 01-PVP-01 & 03 Valve Panels for CNG fill systems
7. Tag No. 01-FMS-02 & 03 Fuel Management Systems
8. Factory acceptance testing by ANGI in Milton, WI.
9. Delivery of equipment to site.
10. Field testing support services.
11. Operation and maintenance manuals and record drawings.
12. Operation and maintenance training in field.

D. Equipment information to be issued as Attachment 1 to Section 400100 at Pre-Bid Meeting will include:

1. General arrangement drawings with equipment weights.
2. Product Data
3. Shop drawings (as available).
4. Equipment delivery schedules.

1.2 PROJECT CONDITIONS

A. Natural Gas: Pipeline quality from WE Energies:

1. Specific gravity: 0.59 (assumed
2. Temperature: 70 degrees F (assumed)
3. Heating value: Varies – assume 1050 Btu/SCF
4. Moisture content: <7 lb./MM SCF
5. Gas pressure at station inlet: 65 psig (nominal)
   Minimum "float" of compressor suction shall be from 40 psig to 80 psig

B. Electrical Service (see Drawings and Division 26 Specifications):

1. Electrical power supplied to compressor's motor starter panel shall be 480VAC ±10%, 3-phase, 60 hertz.
2. Electrical power supplied to dispensers shall be 120VAC, single-phase, 60 hertz.
3. Electrical power supplied at other voltages shall be furnished as shown on drawings.

C. Design Conditions:

1. Compressor System
   a. Compressor suction gas pressure — 40 psig (min); 60 psig (design flow rate); 80 psig (max)
   b. Discharge pressure from compressor — 4,500 psig.
   c. Design flow rate — 500 scfm per compressor
   d. Max gas discharge temperature — 20 deg F above ambient
2. Site:
   a. Ambient temperature — -20 deg F to 95 deg F
   b. Elevation above MSL — 649 ft.

1.3 REFERENCES

A. All equipment and entire packaged fueling system shall comply with latest revisions of applicable codes and standards and Wisconsin Department of Commerce Chapter Comm. 40. All materials shall be new and unused. As a minimum, equipment shall comply with the following codes and standards:
   1. American Gas Association (AGA):
      a. 2-93: Requirements for Manually Operated Valves for High Pressure Natural Gas.
   2. American Petroleum Institute (API):
      a. 520: Sizing, Selection, and Installation of Pressure-relieving Devices.
   3. American Society of Mechanical Engineers (ASME):
      a. Boiler and Pressure Vessel (B&PV) Code:
         1) Section VIII, Division I – Pressure Vessels.
         2) Section IX – Welding and Brazing Qualifications.
   4. American Welding Society (AWS):
      a. D1.1 – Structural Welding Code.
   5. National Fire Protection Association (NFPA):
      a. 52 – Vehicular Gaseous Systems Code – 2002 (per WI Comm. 40).
      b. 52 – Vehicular Gaseous Systems Code – 2010 (for future).
      c. 54 – National Fuel Gas Code – 2009.
      d. 70 – National Electrical Code (NEC) – 2008.
   6. Underwriters Laboratories Inc. (UL):
      a. 508 – Industrial Control Equipment.
      b. 508A – Industrial Control Panels.
   7. American National Standards Institute (ANSI):
      a. B31.3 – Process Piping (ASME Code for Pressure Piping).
   8. Occupational Safety and Health Act (OSHA):
      a. 29 CFR1910.95 – Occupational Noise Exposure.

1.4 QUALITY ASSURANCE

A. Paint, coatings and priming products shall be lead, chromium and cadmium free. In addition, products and all other materials used shall comply with local, regional, state and federal air quality rules and regulations.

B. Materials and surfaces exposed to exterior, unless pre-finished or otherwise treated with a corrosion-resistant finish, shall receive a minimum of a two-coat, shop-applied, epoxy coating system with surface preparation in accordance with SSPC standards and coating manufacturer recommendations.

PART 2 PRODUCTS

(FURNISHED BY OWNER PER CONTRACT WITH ANGI; RECEIVED, UNLOADED, SET AND INSTALLED BY CONTRACTOR)

2.1 CNG COMPRESSOR SYSTEM PACKAGE (02-CMP-02)

A. Natural Gas Compressor System (furnished by ANGI):
   1. CNG Compressor Manufacturer:

a. Ariel Model JGQ.

2. Each compressor system has been sized to handle quoted capacity with gas analysis and conditions specified in Article 1.02, Paragraphs A and C.
3. System will be a self-contained electric-driver package, consisting of an electric motor-driven compressor, control panel with PLC controls, auxiliary systems, and safety devices. Each compressor will be designed specifically to compress natural gas.
4. Compressor will be of multi-stage, reciprocating design. Compressor will be air-cooled trunk piston or cross head design.
5. Compressor cylinders will be splash or pressure lubricated with pressure lubricated crankcase running gear. Compressor lubrication shall be ISO150 grade synthetic oil, or as approved by compressor manufacturer.
6. CNG compressor system enclosure by ANGI:
   a. Totally enclosed weatherproof and sound attenuating enclosure (75 dBA at 10 ft. outside of enclosure) shall be provided for compressor skid.
   b. Enclosure will be of welded steel construction.
   c. One (1) 150W minimum light fixture suitable for Class 1, Division 2, Group D location will be provided complete with explosion-proof wall-mounted manual switch.
   d. Exterior surface will be weatherproof, rain-tight, and factory-coated with manufacturer's recommended coating system.
   e. All doors will be either swing out; shall be lockable; and shall have hold-open devices with means to open at least one door from inside.
   f. ESD Push-button will be located inside system enclosure near primary access door and outside skid enclosure.
7. Each compressor system will be furnished by ANGI with the following items skid-mounted inside enclosure (except for Item A, which shall be installed by Contractor):
   a. Inlet line assembly, including a particulate filter, check valve, fail-closed actuated valve, isolation valve, flexible hose, and relief valve for field installation by Contractor as shown on drawings.
   b. Direct compressor drive.
   c. Interstage gas coolers, gauges, separators, and relief valves.
   d. Piston rings shall have a guaranteed minimum life of 4,000 hours. Supplier shall provide manufacturer's written guarantee of compliance.
   e. Compressor valves shall have a minimum life of 3,000 hours.
   f. Compressor shall have a guaranteed maximum oil carryover after final discharge filtration system of no more than 0.5 lb/MMscf of natural gas.
   g. Fan belts, if required, shall be V-belt, cogged type.
   h. Guards for drive belts and hot surfaces that provide protection in conformance with OSHA and other safety regulations.
   i. Automatic condensate drain system.
   j. Discharge line assembly including pre-coalescing and coalescing filters, relief valve, check valve, and isolation valve.
   k. Parker-type zero tolerance o-ring face seal fittings for tubing sized 1/2-inch to 1-1/2-inch.
   l. Service vent valves to depressurize line for servicing.
8. Equipment vibrations shall not exceed following displacement measured with a three-component measuring system (see Paragraph 2.2.D):

Frequency (cycles per second)	**Displacement (inches)**
0 – 10	0.0020
10 – 20	0.0010
20 – 30	0.0006
30 – 40	0.0004
40 – 50	0.0003
50+	0.0001

9. Electric Motors:
   a. Manufacturers:
      1) A. O. Smith.
      2) Baldor.

3) GE.
4) Regal Beloit (Leeson, Lincoln or Marathon).
5) WEG Electric Motors.

b. Constant speed, NEMA Premium®, TEFC motor.
c. 250 HP/ 480 VAC / 3-phase / 60 Hz / 1800 rpm.
d. Rated for continuous duty with minimum 1.15 service factor.
e. Rated for Class 1 Division 2 Group D location.

B. CNG Cooling System (provided by ANGI on compressor skid):

1. Gas coolers suitable for service in ambient temperatures of between -20°F and 120°F, and designed to deliver gas at a maximum temperature of ambient plus 20°F.
2. Forced draft air circulation will be used to cool CNG form effects of compression. Fan drive may be either derived from prime mover or separate electric motor.
3. Tube material will be seamless Type 316SS, manufactured and labeled according to ASTM A213.
4. Cooler intake and exhaust sections will be oriented so as to minimize introduction of exhaust air into enclosure. Coolers will include sound attenuating louvers at intake and exhaust sections.

C. Gas Recovery System (provided by ANGI on compressor skid):

1. Gas recovery system will recover any gas that is vented during compressor shutdown.
2. Upon compressor shutdown, gas within compressor system will be routed to recovery system to allow unloaded compressor starting.
3. All oil separators will drain to a single manual drain piped to edge of enclosure (Contractor shall provide elbow discharge off skid for open vessel collection by Owner – NOT hard-piped to drain).
4. Gas recovery vessel will be ASME-rated and have necessary capacity and pressure rating to accumulate blowdown gas without relieving gas to atmosphere or to station inlet line.
5. Gas recovery vessel will have a relief valve and manual service vent valve.

D. Vibration Monitoring System (provided by ANGI):

1. Manufacturer:
   a. Wilcoxon Research.
2. Vibration monitoring system (sensor/transmitter, monitor, software) with output to station control PLC and SCADA system for following applications on each compressor:
   a. Cross-head vibration (cross-head looseness for each compressor).
   b. Compressor frame vibration (shaft imbalance) for each compressor.
3. Factory prewired to PLC installed in CNG station PLC control system.
4. Tested during factory acceptance test and log data.

E. Filters (provided by ANGI):

1. Acceptable manufacturers:
   a. Parker / Finite.
   b. Nowata.
2. Inlet Gas Suction Filter:
   a. Sized to filter particulate of 50 micron diameter or greater at maximum compressor flow rate.
   b. Manual drain valve with differential pressure gauge.
3. Interstage Coalescing Filters:
   a. Coalescer downstream of each cylinder between interstage cooler and next-stage compressor inlet.
   b. Sized to eliminate 95% entrained liquids and liquid accumulation from up to 8 hours of continuous operation.
4. Discharge Coalescing Filters:
   a. Two filters (pre-coalescer and coalescer) for each compressor.
   b. Coalescing filters (in-series) as far as possible downstream of final stage aftercooler, but before priority-direct fill valve panel.
   c. Filters sized for discharge not to exceed 50 ppm liquid hydrocarbon or oil.
   d. Pressure drop shall not exceed 2% at compressor's maximum flow rate over gas pressures ranging from 2,000 to 4,500 psig.
5. Automatic Condensate Drain System:

a. Actuated drain valve for each coalescing filter piped to system blowdown tank and controlled by programmable controller adjustable at controller user interface.
b. ASME-rated condensate blowdown tank(s) with sufficient volume for maximum system condensate flow, tank relief valve, and tank drain piped to edge of skid with manual isolation ball valve.

2.2 CNG-STORAGE VESSELS (02-TK-04,-05,-06 – Furnished by ANGI)

A. Manufacturer: CP Industries or FIBA
   1. One (1) 3-pack storage assemblies with ASME-rated CNG storage vessels will be provided (nominal 36,000 scf at 5,000 psig). Each vessel shall be 20 inches diameter x 23 feet long, with capacity of 11,500 scf at 4,500 psig, and MAWP of 5,500 psig, and shall include framing and bracing.
   2. Each 3-pack Vessel Assembly weighs approximately 21,000 lbs.

B. Arrangement:
   1. Tube-type vessel shall be bolted to its foundation by Contractor, by structural steel rack per drawings.
   2. Vent Risers shall be provided by Contractor per drawings.

C. Valves and Drains:
   1. Each vessel will include a full-port 3/4-inch pressure relief valve (PRV) set at vessel MAWP with a full-port 3/4-inch ball valve locked open between PRV and vessel.
   2. Each vessel will include a 3/4-inch service ball valve, and a drain port at its low point with a needle type drain valve.

2.3 FAST-FILL DISPENSERS (02-FD-0-03 – furnished by ANGI)

A. Manufacturer: ANGI Energy Systems:
   1. One (1) dual-hose medium duty 3,600/3,000 psig CNG dispenser with internal fill-control logic for public fast-fill system and display on both sides of dispenser (one hose at 3,600 psig / one hose at 3,000 psig.)

B. Specifications:
   1. Dispensers will be capable of delivering fills of specified CNG temperature compensated to 70°F, based on control logic housed in dispenser.
   2. Dispensers will include two MicroMotion CNG-050 meters, mechanical vehicle pressure gauge for each hose inside cabinet, and shall have a backlit data display.
   3. All CNG tubing and fittings will be 1/2 inch x .065 inch, grade 304/316 SS.
   4. Vent tubing will be 3/8-inch x .049 inch, grade 304/316 SS.
   5. A means of preventing escape of CNG from fast-fill system, in case dispenser is knocked off its base, shall be provided.
   6. Dispenser-control valves will use actuated ball valves.

C. Filters:
   1. Dispensers will include one inline oil-coalescing filter for each of three sequence-bank feed lines and a block and bleed valve arrangement to facilitate servicing of filters. Three total filters will be housed in Parker-Hannifin J2 housings and will include a Grade-4 coalescer element. Filters will be located upstream of meter and control valves in dispenser cabinet.

D. Hose and Nozzle:
   1. Hoses will be 3/8-inch x 12 feet long with 5,000 psig MAWP.
   2. Inline breakaways mechanisms with check valves, which will be electrically conductive.
   3. Nozzle will be NGV-1 Type-2.
   4. Hose will not contact ground when nozzle is in its keeper.

E. Operation:
   1. Dispenser will be controller by internal logic controller.
   2. Dispenser will include internal 3-bank sequencing with 3/8-inch tubing connections to storage array.

F. Interface with Fuel-Management Terminal:
   1. Dispensers shall be configured for connection to CNG industry standard fuel-management terminal, so that terminal must authorize dispensing of fuel, and so that CNG fuel consumption mass is recorded by terminal, along with User ID, time of day, and Vehicle ID.
   2. Pulse-Count Output:
      a. Dispenser will generate 100 pulse-count per mass of CNG dispensed (i.e., 100 pulses per gasoline-gallon equivalent of CNG).
      b. Actual mass-calibration rate shall be diesel gallon equivalent for DPW Fast Fill and Gasoline Gallon Equivalent for Public Access Dispenser.
   3. Contractor shall install connections between each dispenser and fuel management terminal for the following signals:
      a. Handle switch.
      b. Low-voltage meter pulser.
      c. "Authorize" signal.
      d. Conductors of different voltages shall be routed in separate conduits.

2.4 TIME-FILL SINGLE AND DUAL HOSE POST ASSEMBLIES (furnished by ANGI)

A. Manufacturer: ANGI Energy Systems
   1. One (1) Single and Eight (8) Dual Fill Hose Posts setup for Type K barrier rail installation.
   2. Seventeen (17) 1/2-inch x 1/4-inch x 15 feet long electrically conductive hoses, with MAWP of 5,000 psig.
   3. Includes inline breakaways with 1/4-inch male pipe thread at supply end of hose.
   4. Dispenser nozzles will be NGV-1, Type-2 with P-36 profiles for 3,600 psig NGV.
   5. Bourdon tube pressure gauge for manifold pressure at each dual hose post.

2.5 CNG STATION PLC CONTROL PANEL IN ENCLOSURE (furnished by ANGI)

A. PLC:
   1. Programmable logic controller(s) (PLC) will be provided to control compressor operation, priority/time-fill valve panels, and an emergency shutdown system.
   2. PLC Manufacturer: Horner.
   3. Local Display:
      a. Touch-type LCD display.
      b. Fault annunciation.
      c. Operating conditions.
      d. Interface for modifying setpoints by authorized operator.
   4. Programmability:
      a. Owner will have unimpeded access to modify setpoints and operating parameters upon completion of work.
      b. Supplier will provide PC-host software (or similar) as required to modify controller program, including any specialized PC interface connector.

B. Control Panel:
   1. NEMA 3R type (outdoor use) enclosure.
   2. Located on compressor skid.
   3. Compressor keyed on/off switch.
   4. Exterior indicating lights will include "Compressor Running" and "Compressor Fault."
   5. Emergency shutdown push-button and keyed alarm reset accessible from exterior of panel.
   6. All 120-VAC wiring shall be terminated at a single, clearly labeled terminal strip ready for field termination by Contractor.
   7. Additional termination points for remote emergency shutdown push-button stations. (Remote bush-button stations shall be provided by Contractor, except for push-button at compressor, which shall be provided by Supplier.)
   8. Incorporate with SCADA system.

C. Performance Specification
   1. Compressor Starting:

a. Logic in base controller shall prohibit a second compressor from starting within 10 seconds of primary starting compressor, but shall allow both compressors to operate concurrently based on demand from time-fill/fast-fill dispensers and storage pressure, which shall be adjustable.
b. Controller shall facilitate incremental compressor startup based on threshold storage pressure.
c. Incremental compressor start sequence shall be associated with storage-bank pressure; i.e., first compressor starts when bank falls to 3,600 psig, and second compressor starts when mid-bank falls to 3,300 psig. Both setpoints shall be adjustable.
d. Second compressor shall be prohibited from starting based on field programmable time of day.

2. Storage Bypass:
a. Controller shall control and prioritize compressor discharge to time-fill header, priority storage banks, fast-fill direct supply to DPW fast-fill dispensers, or supply to public area storage banks.

D. Shutdowns, Alarms and Annunciations:

1. Compressors (minimum requirement):

a.	High/low suction gas pressure:	shutdown
b.	High interstage pressure (all stages):	shutdown
c.	High has discharge pressure:	shutdown
d.	Low lube oil pressure:	shutdown
e.	High interstage temperature (each stage):	shutdown
f.	High discharge temperature:	shutdown
g.	High compressor/cooler vibration:	shutdown
h.	High oil temperature:	shutdown
i.	Lubricator failure:	shutdown
j.	Excessive motor starts:	shutdown

2. System:

a.	High storage pressure, each bank	shutdown
b.	High blowdown pressure (95% MAWP):	shutdown

E. Emergency Shutdown System:

1. An emergency shutdown (ESD) system shall be provided. When ESD system is activated:
a. Power to PLC outputs, gas supply to compressors, and dispenser(s) are shut off.
b. Signal shall be available to activate optional visual warning devices.
2. ESD System shall be activated by:
a. CNG station shutdown push-buttons (various locations).
b. Loss of station electrical power.
3. System shall not allow station to resume operation without a manual reset and station returning to normal.

2.6 SCADA (SUPERVISORY CONTROL AND DATA ACQUISITION) SYSTEM (Furnished by ANGI)

A. Summary:

1. SCADA System will provide centralized monitoring and recording of programmable controllers for compressors, dryers, priority panels, storage, and dispensers.
2. SCADA System will include computer and program software.
3. SCADA will monitor devices and display natural gas process.
4. Motors, pumps, valves, pressures, temperatures, switches, vibration monitors, etc., shall have a graphical representation.
5. SCADA will manage and monitor CNG processes and facilities management.
6. Graphics, controls, configuration date, and programming associated with SCADA installation will be configured and implemented base on representation of infrastructure equipment deployed at CNG site, allowing entire system to be monitored and controller in real-time.

B. Screens:

1. Screens shall properly display CNG equipment as process piping schematic.
2. Main menu screen shall include a general arrangement representing CNG site.
3. Sub menu screens shall display specific CNG equipment.

C. Ethernet:
   1. CNG equipment PLC will include a built-in Ethernet port with standard TCP/IP.
   2. Each controller will have a unique IP address and be configured to site specifications.
   3. Ethernet port will support 10/100BaseT.
   4. Ethernet protocol to be finalized by Owner with ANGI.

D. Alarms:
   1. Alarm functions shall display alarms (and related alarm help pages), and acknowledge, disable, and enable alarms.
   2. SCADA will provide information about alarms and allow operators to add comments to alarm records.
   3. Alarms will be logged with a time and date stamp.

E. Mapping:
   1. SCADA program will have a tag configurable database that polls CNG stations and tells software which parameters within station are to be accessed.
   2. Database will schedule frequency at which parameters of station are accessed.
   3. Parameters will include measure values, data points, and alarm setpoints.

F. Logging and Trending Data:
   1. Trend graphs.
   2. Trending will provide dynamic visual analysis (trend and graphs), production records and status of equipment, efficiency and preventive maintenance.

G. Messages:
   1. SCADA PC software shall provide messaging for SMS or emails that report status and alarm condition reported to external personnel.

H. Web Browser:
   1. To be finalized by ANGI in submittals.

2.7 MAIN PRIORITY VALVE PANEL (02-PVP-01) (furnished by ANGI)

A. Manufacturer: ANGI Energy Systems:
   1. Priority valve panel will direct flow of CNG from DPW CNG fueling station.
   2. Storage will be accessed first in event of a demand for vehicle fast-filling. If storage pressure drops to set point, station control system will start compressor and shall run until fast-filling demands have been met. If there are not further fast-fill demands, compressor shall replenish storage.
   3. Main priority valve panel control system will direct compressor discharge gas to dispensers or to storage. Control logic for priority for compressor flow is summarized as follows:
      a. First priority: Direct flow to DPW fast-fill dispenser.
      b. Second priority: Direct flow to "Public" priority system fast-fill dispenser.
      c. Third priority: Direct flow to DPW time-fill system.
      d. Fourth priority: Replenish DPW fast-fill storage high to mid to low bank.
   4. In addition to I/O signals required for CNG Station Control, PLC shall interface with following I/O signals:
      a. ESD push-buttons (provided by Contactor as shown on drawings).
      b. Storage pressure.
      c. Actuated valves in valve panel.
   5. ESD valves shall fail closed.

2.8 PRIORITY VALVE PANEL (02-PVP-02) (PUBLIC FAST FILL AREA – furnished by ANGI)

A. Manufacturer: ANGI Energy Systems:
   1. Priority valve panel will direct flow of CNG from DPW CNG fueling station to public fueling dispenser (02-FD-03).

2. Storage will be accessed first in event of a demand for vehicle fast-filling. If storage pressure drops to set point, station control system will start compressor and shall run until fast-filling demands have been met. If there are no further fast-fill demands, compressor shall replenish storage.
3. Priority valve panel control system will direct compressor discharge gas to dispensers or to storage. Control logic is from system PLC priority for compressor flow summarized as follows:
   a. First priority: Direct flow to DPW fast-fill dispenser.
   b. Second priority: Direct flow to "Public" priority system fast-fill dispenser.
   c. Third priority: Direct flow to DPW time-fill system
   d. Fourth priority: Replenish DPW fast-fill storage high to mid to low bank.
4. In addition to I/O signals required for CNG Station Control, PLC shall interface with the following I/O signals from this Priority Valve Panel:
   a. ESD push-buttons (provided by Contactor as shown on drawings).
   b. Storage pressure.
   c. Actuated valves in valve panel.
5. ESD valves shall fail closed.

2.9 SEQUENTIAL TIME-FILL PANEL (02-PVP-03) (FOR DPW METERED SEQUENTIAL FILL)

A. Manufacturer: ANGI Energy Systems.

B. Time-Fill Flow Metering:
   1. Includes one (1) MicroMotion CNG-050 coriolis gas flow meter for measurement of flow dispensed through time-fill dual hose post-assemblies, based on individual, sequenced fill at each time-fill post-assembly via PLC control.

C. Solenoid valves for sequential time-fill will be factory-installed and pre-wired in Time-Fill Panel.

D. Sequential Time-Fill System and Fuel Management Control Logic (or equal):
   1. Time-fill supply flow transmitter shall measure and transmit flow data from time-independent time-fill system branch supply header.
   2. Each time-fill hose post solenoid valve shall be electromechanically controlled to open and close for filling vehicle.
   3. Only one solenoid valve shall be open at a time, to enable measuring of flow to time-fill hose dispenser connection via common supply header flow meter; therefore, time-fill shall be sequential-fill at time-fill dispensers.
   4. Vehicle driver (with unique ID number) will connect truck (unique ID number per truck) to a time-fill hose (with unique ID number per hose dispenser), and input corresponding ID numbers in time-fill fuel management system controller.
   5. Driver and equipment ID shall be authenticated for accuracy before time-fill fueling at hose dispenser is authorized.
   6. Each additional vehicle will follow similar connection to time-fill hose system and will be added to "queue" for sequential filling via CNG compressor system.
   7. At programmable "start-time" for time-fill fueling session (i.e. evening shift), control system shall authorize compressor start to sequentially fill vehicles by opening and closing solenoid valves based on authorization order in system queue.
   8. Control system shall monitor temperature-compensated pressure in header to indicate when vehicle CNG fuel tank is "full" and sequence opening next valve filling next vehicle in time-fill queue.
   9. Upon satisfying fill pressure for last vehicle in queue, control system shall:
      a. Signal end of time-fill session.
      b. De-authorize time-fill session.
      c. Log quantity of fuel from flow meter data by hose ID, vehicle ID, and Driver ID.
   10. City of Milwaukee Fleet Services Administrator shall be able to extract site data through host control processor database management application for export to Excel, CSV, or other specific format.

E. Any interruption or errors in time-fill sequence shall be alarmed and documented by control system.

2.10 INSTRUMENTATION AND CONTROLS (Provided by ANGI on Pre-wired Skids)

A. All pressure gauges shall conform to following requirements:

1. All gauges will read at least 1.2 times system design pressure (NFPA 52).
2. Accuracy, including hysteresis, will be +0.5% of full-scale or better.
3. Rear blowout protection will be provided.
4. All gauges will be waterproof and liquid-filled.
5. Dial will have a minimum diameter of 2-1/2 inches.

B. Instrument components interfacing with natural gas will be made of material compatible with odorized natural gas. No copper metal or alloys containing more than 70% copper shall be used in natural gas service.

C. Gauges and manually operated valves shall be located no higher than five (5) feet above grade.

D. Pressure gauges will be installed at following locations as a minimum:
1. Suction pressure downstream of suction filter.
2. Interstage pressures at filters and cooler.
3. Oil pressure on compressor frame oil filter.
4. Final discharge pressure at discharge filters.
5. Blowdown vessel pressure.
6. Control gas pressure (if installed) downstream of regulator.

2.11 FUEL MANAGEMENT SYSTEM (02-FMS-02,-03) (Furnished by Owner)

A. Manufacturer: AssetWorks.

B. Equipment details to be provided with Attachment 1 to this section at Pre-Bid Meeting.

2.12 PIPING / TUBING ON SKIDS (Furnished by ANGI)

A. Piping and tubing systems will be rated for maximum pressure and temperature to which they will be subjected under normal operating conditions, and be properly supported and protected to prevent damage from vibration during shipment, operation, and maintenance. Piping and tubing systems shall be installed in a neat and orderly arrangement, adapting to contours of skid package. Piping and tubing systems shall not obstruct access openings. Supports shall not be welded directly to piping or tubing.

B. Piping design, inspection and testing shall be in accordance with ANSI/ASME B31.3. Piping shall be seamless, minimum Schedule 40 (standard weight), and conforming to ASTM A53 or A106 Grade B. Cast iron or semi-steel piping will not be used. Testing shall be pneumatic.

C. Gas tubing on compressor skid will be seamless stainless steel ASTM A269, Type 316. Hardness of stainless steel tubing shall be no more than Rockwell hardness of 80. All tubing fittings used throughout station system (compressor skids, dispensers, storage, and inter-skid connections), will be Parker Seal-lok® o-ring face seal for 1/2-inch and larger diameter and Gyrolok® 316 stainless steel for smaller than 1/2-inch diameters.

D. Piping will be prepared and painted in accordance with manufacturer's standards.

E. ANGI will provide drain lines brought to skid edge and allow draining into a container placed on ground next to skid.

2.13 EQUIPMENT TAGS (Furnished by ANGI)

A. All equipment, including storage vessels, tanks, heat exchangers, instrumentation (gages, transducers, etc.), all valving (isolation, bleed check, regulation, solenoid and relief), and panels will be provided with an equipment tag and unique tag number matching equipment ID number on D. Tags will be laminated plastic with black letters on white background, or approved equal. They will be attached to flat surfaces of equipment using an epoxy adhesive or wired to equipment with stainless steel wire.

PART 3 EXECUTION

3.1 FACTORY ACCEPTANCE TESTING (By ANGI per Owner Contract with ANGI)

A. Prior to shipment, CNG compressor shall be operated for a minimum of four (4) continuous hours and functionally tested. Test shall include, but not be limited to the following:

1. Operation of compressor control.
2. ESD system test.
3. Load testing.
4. Auto start/stop testing.
5. Safety shutdown testing.
6. Alarm testing.
7. Noise and Vibration analysis.
8. Motor testing.
9. Lube oil system testing (pressure and temperature).
10. Fan testing.
11. Compressor interstage pressure and temperature testing.

B. Factory acceptance test parameter data shall be logged with readings, time and date and signed by authorized supplier representative.

C. Acceptance by Owner of witnessed test shall not release Supplier from any of its warranty obligations, or any other obligation, under this Specification.

3.2 DELIVERY

A. Supplier shall ship CNG compressor, dispensers, storage tanks, and all accessories to corresponding CNG vehicle fueling station site.

3.3 FIELD INSTALLATION

A. System equipment shall be received, unloaded, set in place, wired and piped to operate all gas drying, compression, storage, dispensing, control, and fuel management in accordance with manufacturer's shop drawings and installation instructions.

B. Installation shall be completed in accordance and in compliance with all applicable local and national Codes and Standards.

C. All components shall be tested in accordance with NFPA 52, NFPA 54, or other applicable CNG industry standards.

D. Pre-start Pipe Cleaning: All piping sections between packaged components that include piping or tubing shall be blown clean prior to connection to equipment. Blow-out shall be achieved by closing the downstream end of pipeline with a 5000 PSI-rated ball valve, connecting a minimum 1650 PSI-source pressure vessel to the upstream end of the pipeline, opening supply valve at source so that minimum 750 PSI accumulates in pipeline, then opening outlet ball valve to atmosphere. Procedure shall be repeated until no solid or particulate matter is discharged from the pipeline.

1. Personnel opening and closing ball valve at downstream end shall take care to keep clear of the discharge path of the blowout, and shall wear eye and ear protection during procedure.
2. Direction of blowout flow shall be performed in both directions, if possible.
3. Contractor shall take care to clear area at pipeline discharge to prevent property damage or injury during procedure.

E. Startup Filtration: "Witch's hat," or similar strainer device, shall be installed where practical at termination of such piping sections prior to system startup and shall be checked, cleaned and replaced by the Contractor as required, until all residual pipe debris has been removed.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services (By ANGI per Owner Contract with ANGI)

1. Supplier's or manufacturer's technician for equipment specified herein shall be present at jobsite for minimum man-days included (travel time excluded) for assistance during plant construction and plant startup:

a. Two (2) man-days for Installation Support Services to Contractor.
b. Five (5) man-days to support Field Testing by Contractor and conduct Field Training.
c. Two (2) man-days for Post-Startup Services.

B. Acceptance by Owner of CNG fueling system under this specification shall occur only after the following requirements have been met:

1. Demonstrate to satisfaction of Owner that CNG fueling station as a whole meets and conforms to requirements of specification and drawings.
2. Testing required by this specification has been successfully completed and has been accepted by Owner.
3. Date of acceptance of fueling station shall be date of written notice of its acceptance by Owner to Supplier. All warranties and/or guarantees referred to or implied in this specification shall commence on that acceptance date.
4. Acceptance by Owner of witnessed test shall not release Supplier from any warranty obligations, or any other obligation, under this specification.

3.5 FIELD ADJUSTING, BALANCING AND TESTING BY CONTRACTOR

A. After completion of the installation, start, regulate, calibrate, adjust and test all equipment and devices.

B. Leak and pressure testing in accordance with Section 400500, Process Mechanical Piping and Tubing System.

C. Functional Tests:

1. Test ESD/Emergency shutdown at all button-station locations, including required valve closures.
2. Test low suction pressure, each skid; close skid-supply ball valves.
3. Test temperature-compensated dispenser fill for each dispenser, including correct dispenser start on button, auto-stop on fill completion, and verify ‘settled’ fill pressure vs. ambient temperature two (2) hours following fills. Pressure shall be within 4% of design-fill pressure temperature compensated to 70°F.
4. Test for correct operation of fuel-management system at each fast-fill dispenser, and time hose post hose, including: authorization of transaction, energizing of dispenser, and recording of transaction data (fill volume, time/date stamp, event ID, and pump number).
5. Test dryer regeneration based alarm on dew point – general false positive at hygrometer.
6. Test for correct annunciation on controller/PLC shall be required for all test events, as appropriate.
7. Observe compressor operation, including stage pressures and temperatures, and verifying function of controller, including triggering selected faults, such as high interstage temperature.

D. Reliability Test:

1. Reliability test shall consist of fueling under normal-use conditions for five (5) consecutive work days.
2. System shall have no failures of compressor operation, dryer operation, normal dispenser operation, or operation of the fuel-management system during the test period. If any failure occurs, the test shall be repeated in its entirety.
3. Final acceptance of the facility shall only be declared upon successful completion of the test.
4. Contractor shall be responsible for all onsite coordination of troubleshooting and coordination of suppliers and trades during test.
5. Failure shall be defined as the occurrence of any of the following:
   a. Inability of the CNG system to dispense CNG at the pressures and rate specified, including accounting for temperature compensation at settled conditions.
   b. Failure of the dryer to provide dried gas and/or not be able to auto-switch or regenerate.
   c. Failure of a compressor to start and run within factory-listed operating pressures and temperatures.
   d. Failure of the controller/PLC, valve panel, fuel-management system, and/or dispensers to operate as specified.
   e. Presence of an audible or visible gas of CNG leak.

f. Occurrence of an auto-fault shutdown of either or both CNG compressors, except those caused by ESD-button activation, gas-detection system outside of skids, variations in gas supply pressure, or damage to facility beyond the Contractor's control.

6. Contractor may take equipment offline for scheduled maintenance during the test period, provided maintenance is consistent with manufacturer's recommendations and does not impinge on Owner's ability to fuel vehicles during the normal daily fueling window between 7:00 a.m. and 11:00 p.m.
7. Contractor shall be responsible for maintenance through successful completion of test, including provision of consumables.
8. Corrective work conducted by the Contractor and all subcontractors and suppliers preceding and during performance test shall be documented at time of repair by technician performing repair. If technician suspects a cause of fault that is beyond scope of his respective firm or responsibility, technician shall notify Owner immediately and shall not implement repairs until condition of failure has been documented and other firm(s) have been notified and been provided documentation of condition.
9. Owner shall not pay Contractor for any work or repair that is implemented during testing above contract amount, unless work or condition is beyond control of Contractor, Contractor's subcontractors, or Contractor's suppliers.
10. Contractor shall notify Owner in writing of intent to perform any work that Contractor deems to be outside of contract scope, prior to performance of any such work.
11. Any discrepancies in Contractor's materials or workmanship found as a result of these inspections and test shall be corrected by Contractor at no cost to Owner, including cost for making all corrections and repeating test within two (2) weeks.

3.6 CNG FUELING OPERATION AND MAINTENANCE TRAINING (By ANGI per Owner Contract with ANGI)

A. On-site Training:
   1. General:
      a. At least 60 days prior to scheduled date for commencement of training, submit training syllabus with time allotments per topic and instructional materials to Owner for review and approval. Upon review of syllabus, Owner may require additional time be allotted to certain training topics.
      b. Develop and conduct a program to train ten (10) Owner-personnel in the safe operating procedures, and maintenance of equipment and systems furnished, during hours required by Owner. Also include in training program key hazards and their protectors, and corrective actions for violation of safety rules.
      c. Furnish instructors, instructional materials, and audio-visual aids and equipment.
      d. Owner shall furnish physical facilities and equipment.
      e. Begin instruction upon successful completion of field testing.
   2. Program Content: At a minimum, instruction will include material covered in operation and maintenance manuals, as well as the following:
      a. Theory of operation of CNG system.
      b. Practical aspects of operation.
      c. Description of system, equipment and components.
      d. Functional characteristics of system, equipment and components.
      e. Emergency operating procedures.
      f. Maintenance procedures.
      g. Servicing intervals and schedules.

B. Duration:
   1. Training for maintenance, facility operation, and troubleshooting shall be eight (8) total hours (minimum).

END OF SECTION

SECTION 400500
PROCESS MECHANICAL PIPING AND TUBING SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Piping and tubing work required in installation of Compressed Natural Gas (CNG) Station. Work includes:
      a. Supply, installation and hookup of piping and tubing listed herein and shown on drawings, and as required to accomplish complete and functioning system consistent with Owner's requirements.
      b. Complete installation of natural gas fueling equipment and gas control systems and necessary connections.

1.2 RELATED SECTIONS

A. General Requirements.

1.3 REFERENCES

A. Applicable provisions of following standards shall apply to work of this Section, except as modified herein, and are hereby made a part of se Contract Specifications to extent required:
   1. ASME Section IX, Welding and Brazing Qualifications.

1.4 QUALITY ASSURANCE

A. Field and Shop Personnel Qualifications
   1. Tube fitters shall provide a letter from local Swagelok, Hoke or Parker representative certifying training in proper makeup and inspection of vendor's products.
   2. Pressure welding shall be performed by certified welders per ASME Section IX to registered welding procedures.
      a. Certification and registration shall be by a National Board (N.B.) registered Agency.
      b. Shop pipe welding procedures shall be GTAW root pass SMAW, GTAW, or a combination for filler passes.
      c. Site welding shall be SMAW root and filler passes.
      d. Each welder shall permanently stamp welds with welder's identification number and pipe spool weld identification number.
   3. Performance test cards shall be copied and submitted to Owner for documentation purposes and shown to Engineer when requested.
   4. Welding and piping and tube fitting work on site, regardless of pressure, shall use persons possessing current journeyman qualifications.

B. Installer Qualifications
   1. Piping subcontractor shall submit proof of successful completion of a minimum of three (3) projects in previous three (3) years that required significant process piping and high pressure (5000 psi) stainless steel tubing installation.
   2. Piping subcontractor shall be required to provide references and staffing lists for se projects and a proposed staffing list for this project to demonstrate that proposed staff will have required experience.

C. Mill Test Certificates: Gas piping, tubing, and fittings shall be as listed below and shall be ordered with mill test certificates and/or certificates of compliance, which shall be submitted to Owner.

D. Regulatory Requirements: Per General Sections, and the following:
   1. Notify Owner and local plumbing inspection agency at least fourteen (14) days in advance of any on-site pressure testing to allow witnessing tests.

1.5 SUBMITTALS

A. Submit in accordance with applicable provisions in Section 013300 the following:
   1. Qualifications:
      a. Procedure Qualification Records and Welding Procedure Specification for certified welders.
      b. Performance test cards.
      c. Tube fitters' qualification letters.
      d. Piping subcontractor's qualifications as indicated.

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with General Requirements and the following:
   1. Pipe and tubing shall be handled in a manner to prevent possible damage to walls or ends or scratching of tube O.D. (Outside Dimension). Pipe and tubing shall be unloaded by lifting at both ends of any one length to avoid bending and placing section carefully upon a padded skid such that entire length is uniformly supported to prevent bending or flexure.

PART 2 PRODUCTS

2.1 GENERAL SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS

A. Piping work specifically listed herein and shown or indicated on drawings. Work includes supply and installation of the following:
   1. Installation Contractor is responsible for supplying all interconnecting components, except components supplied by equipment supplier as noted on drawings.
   2. Complete installation of gas piping system and necessary connections to equipment, except where noted as supplied by WE Energies.
   3. Installation of piping facilities required for proper operation of facilities.
   4. Compressor inlet gas piping from gas dryer block and bypass outlet to gas compressor(s). Gas piping shall be minimum 4-inch Schedule 40 with 3-inch reducers at compressor 02-CMP-02. Install 3-inch ANSI 150 regulator, 3-inch x 36-inch ANSI 150 stainless steel flexible connector and 3-inch ANSI 150 lockable ball valve upstream of compressor inlet flange as furnished by Owner (via ANGI).
   5. High pressure gas piping and tubing as indicated in specifications and drawings, and as required to give a fully operational station. This will include installation of valves, fittings, filter, gages, sleeves and tubing between compressor package and storage, and between compressor package and storage and dispensing systems.
   6. Provide 2-inch Schedule 80 vent pipe manifold and required supports and bracketing from PSVs on each CNG storage assembly to a minimum of 10 feet above grade. Pipe unions shall be provided at each PSV to allow for easy removal and replacement of PSV. Vent stack shall have a vertical discharge with rain cap (tack welded to stack and weighted for closure) and be equipped with a drip pocket with drain valve located approximately 24 inches above grade.
   7. Provide 2-inch Schedule 80 vent piping and required supports and bracketing from Priority Valve and Time Fill panels to a minimum of 10 feet above grade. Vent stack shall have a vertical discharge with rain cap (tack welded to stack and weighted for closure) and be equipped with a drip pocket with drain valve located approximately 24 inches above grade.
   8. Interconnecting tubing and piping shall be installed as required by installation and manufacturer's drawings, as indicated in specifications, and as required to give a fully operational station. Tubing shall be installed with expansion offsets and U-bends as required, to allow for differential heaving and settlement of equipment pads and trench. All aboveground tubing and piping shall be laid out/configured and connected in a manner that allows each section to be removed without disassembly of adjacent piping, tubing, or equipment.
   9. All tubing installed in underground sleeves is to be coiled continuous lengths – no fittings or welded connections are permitted on underground tubing.
   10. Signs and labels as specified in drawings.

2.2 MANUFACTURERS AND PRODUCTS

A. Gas and CNG Tube Fittings: Shall be from same manufacturer, 316 Stainless Steel (SS) Swagelok, Hoke Gyrolok, or Parker A-lok.

B. Screwed pipe fittings may be SA 105 or carbon steel or 316 SS, as manufactured by Swagelok or Hoke.

C. Tapered Thread Sealant: Crawford "SWAK" anaerobic liquid Teflon thread sealant, Crawford "Strip-Tease" Teflon tape, or approved.

D. Gages: Supplied by Swagelok, Ashcroft, or WIKA.

E. Low Pressure (less than 500 psig) Ball Valves (including actuated ball valves): Three-piece, carbon steel ball valves with stainless steel trim, manufactured by one of the following: Worchester, Watts, or SVF.

F. High Pressure (more than 500 psig) Ball Valves (including actuated ball valves): Stainless steel ball valves with stainless steel trim, as manufactured by Worchester, Watts, SVF, or Swagelok.

1. Valves up to and including 3/4-inch: Swagelok (SS-AFS series) or equal.

G. Check Valves: 316 stainless steel Hoke Series 691F.

H. Drain Valves on Filters, Vessels and Throttling Valves: Stainless steel Swagelok Rising Plug series SS-4PD or SS-5PD, with replaceable seats.

I. PSVs: Pressure Safety Valve (pressure relief/safety relief valves) carbon steel or stainless steel bodies with stainless steel trim and ___UV stamped N.B. rated. PSVs shall be as manufactured by Anderson Greenwood or Mercer.

J. Bleed Valves Required for Service: Swagelok BV series bleed valves or Swagelok Rising Plug series SS-4PD with replaceable seats.

2.3 MATERIALS

A. Valves, fittings, instrumentation and/or mechanical components that are not specifically called out in this Spec Section, shall be non-proprietary, third party supplied.

B. Gas Flow Piping and Tubing:

1. Components containing gas shall be carbon steel or stainless steel as indicated below. Vehicle filling hoses are considered to be the only exception to this rule.
2. High Pressure Gas Piping: Compressed Natural Gas (CNG) where shown as carbon steel on plans:
   a. Carbon Steel: ASME SA106B seamless pipe, Grade B, Schedule 160 for 1" pipe size or less, and Schedule XXS for 1-1/2" or 2" pipe size.
   b. Fittings shall be Class 6000, forged steel, ASTM A105 butt weld.
   c. Flanges shall be Class 2500 forged steel, ASTM A105 weld neck, RTJ or RF, conforming to ANSI B16.5 with bore matching inside diameter of pipe.
   d. Flange bolts and studs shall be ASME SA193 Grade B7, with heavy hex nuts, ASTM A194, Grade 2H, and shall show minimum of (2) through backing nut when fully tightened.
3. Gas Tubing: ASME SA213 Type 316 Seamless, cold-drawn stainless steel. This includes gage lines, pressure transducer sensing lines, and pilot pressure gas lines. TP316L and TP316N stainless steel tubing is not permitted. Surface hardness shall not exceed Rockwell B90. Diameters and wall thickness as follows:
   a. 1-inch O.D. x 0.120 inch minimum wall.
   b. 3/4-inch O.D. x 0.109 inch average wall.
   c. 1/2-inch O.D. x 0.065 inch average wall.
   d. 3/8-inch O.D. x 0.049 inch average wall.
   e. 1/4-inch O.D. x 0.035 inch average wall.
4. Compression fittings shall be type 316 SS swaged fittings and shall have minimum working pressure of 6000 psi. Flared fittings will not be permitted.
5. Zero clearance fittings or pipe: U-bends must be used where actuated ball valves, safety relief valves, check valves, and the like, need to be removed for servicing. Zero clearance fittings must be verified to meet design pressure of system.
6. Threadolets, flanges, swaged nipples, plugs and bushings shall be ASME SA105. Butt-weld pipe fittings, including elbows, returns and reducers, shall be ASME SA234 WPB. Socket-weld fittings are not acceptable.

7. Pipe unions shall only be used on vent lines. Weld-neck flanges are approved method of connecting pipe spools to equipment; slip-on flanges are not approved. RF flanges shall be used on ANSI Class 900# and lower flanges, as well as on any ANSI Class 1500# and higher flanges requiring a flange isolation kit. Ring Type Joint (RTJ) flanges shall be used on ANSI Class 1500# and higher flanges not requiring a flange isolation kit.
8. Screwed pipe and fittings shall be used only where a transition to tubing is required, or for gas service (2-inch or smaller) with pressures below 15 psig, or for vent lines. Use of stainless steel threaded fittings in combination with compression fittings shall be minimized. Seal welding of threaded fittings is prohibited.
9. Where threaded fittings are necessary on gas piping, fittings shall be selected and arranged such that positioning of fitting is flexible. **Use of tees or elbows with compression ends and threaded end on same fitting is prohibited.** In such a case, a union tee or elbow shall be used in conjunction with a male or female tube adapter.
    a. Some female pipe thread fittings cannot be used downstream of compressor since not rated to high enough pressures. In addition, pressure safety relief valves must be installed as can be removed and replaced without having to turn PSV to loosen or tighten it. A flange, compression fitting, or zero clearance fitting on inlet and outlet, in compliance with above, shall be used. Pipe unions may be used on PSV vent piping only.
10. Tube fittings, in all cases, shall all be of same manufacturer and shall be of same material as tubing.

C. Gas Vent Lines:

1. Gas vent lines shall be of same materials as specified for gas flow lines. Each line shall be Schedule 80 minimum and sized to match outlet size or maximum flow capacity of PSV it serves, whichever is greater. Each vent stack shall be sized to match total maximum flow capacity of relief valve it serves. Compressor vent stack is to be a minimum of one pipe size greater than compressor suction piping (2-inch Schedule 80 minimum).
2. Air and gas safety relief valves shall be piped to discharge vertically a minimum of 5 feet above roof of shelter (if applicable) and a minimum of 12 feet above surrounding grade, whichever is greater. Vent pipes shall be provided with a drip pocket to trap liquids and/or solids. This pocket shall be located within enclosure (if applicable) and shall be equipped with a manual drain valve. Vent lines shall be securely fastened, and vent stacks shall be given sufficient support to prevent pipe movement during a discharge event. Vent stacks shall also be equipped with rain caps to prevent airborne rain and snow from contaminating vent piping. Note that gas and air vent systems shall be piped such that mixing cannot occur.
3. Compressor packing shall be externally vented and shall be piped separately from safety relief vent piping and provided with a drip pocket to trap liquids and/or solids. This pocket shall be located within enclosure and equipped with a manual drain valve.

D. Instrument Air Lines (IF REQUIRED): Shall be ASME SA213 TP316 tubing as specified in subparagraph 2.3.B.4 above.

1. Use of stainless steel tubing and fittings of same manufacturer selected in paragraph 2.2.A above, or minimum 200 psi rated (4:1 safety factor). Teflon air line with fittings of same manufacturer selected in paragraph 2.2.A above will be allowed within panels or within equipment skids and shelters or within conduit sleeves, provided sleeve riser enters directly into a pullbox where a transition to stainless steel tubing or carbon steel pipe is made. Air lines installed between equipment skids or panels shall be either 316 SS tubing or carbon steel pipe.
2. Above-ground fittings shall be threaded, and valves shall be two-piece, 600 lb. WOG rated ball valves with steel handles and locking kits.

E. Miscellaneous Piping Components

1. Flange gaskets shall be spiral wound metallic with centering ring (up to ANSI 900# RF, non-isolation), malleable iron (ANSI 1500# RTJ and higher, non-isolation), or phenolic (up to ANSI 2500# RF flange isolation kits only), or a material approved by Engineer. Gasket materials shall be non-flammable, non-asbestos materials.
2. Insulated Flange Kit for dissimilar metal connections (stainless steel tubing connection to carbon steel pipe where shown on drawings):
    a. Kits for raised face flanges shall include insulated full face flange gasket, 1/8" thick, with phenolic retainer and Viton sealing element. Pipeline Seal and Insulator, Inc., linebacker type E, or equal kits for ring-type joints, shall include a Type D gasket.

b. Kits shall include the following:
    1) Full-length phenolic sleeve, extending halfway into both steel washers for each flange bolt.
    2) Two (2) 1/8" thick phenolic isolating washers for each bolt.
    3) Three (3) 1/8" thick zinc-plated hot-rolled steel washers for each bolt.
    4) Inside diameter of washers shall fit over isolating sleeve.
    5) Minimum dielectric strength of 400 volts/mil and water absorption <0.10%.
3. Threads shall be NPT if tapered, or SAE if straight, unless otherwise specified.
4. Bolts, tubing, piping and fittings shall be to SAE (i.e. non-metric) standards. Bolts shall be threaded UNF or UNC.
5. Swivel hose ends and fittings shall be 37 degree flare cadmium or zinc plated carbon steel.
6. Gages shall be equipped with stainless steel wetted parts and rated at 4:1 safety factor (minimum). Gages shall be equipped with a blow-out disc in case. Gages shall be selected to provide normal operating pressure (at maximum suction and discharge conditions) at approximately 60 percent of range. All gages shall be glycerin filled.
7. Compressor inlet valves, factory-installed on compressor skid by ANGI, shall be rated fire-safe to API 607. Lever-operated valves must be equipped with locking kits capable of securing valve in either an open or closed position. Actuated and manual ball valves shall be equipped with high cycle life stem and seals and shall be positional in any orientation. Actuators shall be mounted to ISO or equivalent standards, using a minimum of 1/4-inch wall square steel tubing or valve manufacturer-supplied bracket. Mounting bracket shall be fastened to ball valve and actuator with a minimum of (4) stainless steel bolts with split lock washers. Actuator/ball valve assemblies shall be factory-tested for proper alignment and operation.
8. PSVs, actuated valves (valve stem vertical, actuator above or below valve), and filters shall be mounted in normal vertical orientation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Piping and Tubing Bending and Fitting Practices:
1. Piping and tubing shall be installed in a manner consistent with Contract Documents; in straight, evenly spaced, parallel runs and properly insulated, if indicated on drawings. Piping systems shall be built, supported and pitched to provide suitable venting and draining. Piping shall be run true to vertical and horizontal axis of facility wherever possible. If type of installation requires a slope on pipe, slope is to remain even along pipe. Overhead piping shall be installed to provide a minimum of 8 foot headroom in passageways. Valves shall be accessible for ease of operation, maintenance and overhaul/replacement. Bends shall be minimized wherever possible. Pipe bends shall not be permitted. Tubing shall be bent using benders that minimize radial distortion. This distortion shall not exceed code requirements.
2. Underground tubing sleeves shall be HDPE SDR11 conduit. Sleeve risers shall be a minimum of 6 inches above pad or 12 inches above ground where cap is installed. Caps are to be drilled with 1/2-inch holes for tube penetration and dry-fitted, not cemented to sleeve.
3. Pipe and tubing shall be cut with a cutter intended for application. Use of a hand hacksaw is prohibited, unless a Swagelok tube vise and guide is used. Use of a power hacksaw or band saw shall be allowed for pipe and 1-inch and larger tubing only, provided cuts are square. Cuts shall be debarred externally and internally. Tubing shall be free of scratches subsequent to cutting and deburring. Filings and cuttings shall be removed prior to assembly. Compression fittings and threaded fittings shall be bench-made wherever possible (i.e. factory or field-preassembled before installation to minimize leaks due to poor or misaligned connections.) A hydraulic swager shall be used for 3/4-inch and larger tubing.
4. All sections of tubing and piping shall be designed to allow safe and controlled depressurization. This will required that bleed valves be installed at various points in system that could be captive. Drain valves on filters considered to be acceptable depressurization points. Valves shall be identified and tagged with a unique identification number, and standard depressurization procedures shall be provided describing in detail by reference to valve numbers how to safely depressurize, purge and re-pressurize all systems in station.

B. Pressure Welding and Fitting Practices:

1. Construction – General Requirements:
    a. Provide welding materials, equipment, tools and supplies of a size, grade and quality approved by Engineer.
    b. End Preparation and Fit-up: End preparation or beveling shall be made by hand filing, machine tool, or flame-cutting device. Cut surfaces shall be smooth and regular. Free-hand torch beveling shall not be permitted, unless previously authorized on a case-by-case by Engineer. Rust, scale, mill slag, primer, moisture, oil or material which may be detrimental to finished weld, shall be completely removed from weld area. Ends of pipe, fittings, and valves shall be cleaned beyond beveled edges at least (2) inches both internally and externally to assure to foreign material enters weld puddle. Cleaning of weld bevels shall be done with power or hand tools.
    c. Line up Clamps: Abutting edges of weldments shall be held in alignment by an approved type of line-up clamp where practical. When welding fitting to fitting, where an approved type of line-up clamp is not practical, each fitting shall be properly supported so as to minimize movement and strain during welding. Short runs of station piping or runs of pipe of limited distances shall demand an approved external line-up clamp. When using an external line-up clamp, clamp shall not be removed until stringer bead segments have been uniformly spaced around circumference of pipe and shall have an accumulative length of at least 50 percent of pipe circumference.
    d. Alignment: Alignment of abutting ends shall be such as to minimize offset between surfaces. For pipe of same nominal wall thickness, offset shall not exceed 1/16 inch. Any greater offset, provided it is caused by dimensional variations, shall be equally distributed around circumference of pipe or fitting.
2. Electrodes:
    a. Size of Electrodes: Welding shall be completed using electrodes according to electrode size and classification listed on certified welding procedure.
    b. Electrode Protection: Welding electrodes shall be kept dry and protected from any mechanical damage or deterioration and shall not be used if found or suspected to be defective.
    c. Burned or defective electrodes shall not be dropped on ground or in raceway, but shall be discarded in a proper container.
    d. Low hydrogen electrodes come in a hermetically sealed container. When a new container is opened, electrodes shall be placed in an electrode heating oven, manufactured and designed for purpose of electrode storage. Electrode shall be heated to 500 deg. F for a period of two hours at a temperature of no less than 500 deg. F.
3. Welding:
    a. Manual Shielded Metal Arc Welding: Welding shall be accomplished by use of low hydrogen type electrodes, except for first pass.
    b. Root bead and hot pass shall be deposited using convention electrodes designated for that particular application. All filler and cover passes shall be completed by using low hydrogen electrodes.
    c. After a weld has been started, no movement (or than rolling on a fixture) of piping shall be permitted until after weld has been completed.
    d. ‘Hot pass’ or second bead shall be commenced as soon as possible after completion of root bead, and in any case, within (5) minutes after completion of root bead. A completed weld shall consist of at least three (3) passes. Under no condition shall a weld of only (2) passes be acceptable in manual shielded metal arc welding. Each successive pass shall be started at 120 degrees separation from previous two start points.
    e. Dirt, scale and slag shall be removed from each bead and groove, between passes, and after weld has been completed with hand or power tools.
    f. Unless welding procedure states otherwise, no weld pass shall commence until preceding pass has been completed.
    g. Cover of cap pass shall be raised a maximum of 1/16-inch above pipe wall, with a width sufficient enough to cover at least 1/16 inch on each side of weld groove. A concave cap shall be repaired by addition of another pass.
    h. Welds must be spaced a minimum of one and a half nominal pipe diameters away from any adjacent weld.

i. Ground Clamps: Welding of ground clamps to pipe or fittings shall be not permitted. Ground clamps shall be constructed in such a manner as to fit uniformly and securely enough to eliminate any possibility of arc burns on pipe or fittings. Ground clamps shall be kept in a good state of repair, lubricated regularly and cleaned when required, of rust, slag, spatter, scale, primer, and coating materials, so as to prevent arc burns.
j. Rapid Cooling Control: When temperature falls below 20 degrees F, welds shall be protected against rapid cooling by wrapping completed girth weld with an insulated blanket designed for that purpose.
k. Blankets shall be applied after completing first three passes, if remaining fill and cover passes are not applied immediately following completion of hot pass. When welds are protected by this method, and when remaining fill and cover passes are completed at a later time, weld area must again be preheated to proper temperature.
l. Wear Protection: Welding shall be performed within a wear-proof enclosure to prevent rain, snow, or foreign objects from contaminating work. Glare from arc welding shall be blocked by use of commercially available weld curtains.
m. Exposed Pipe Joints: Pipe joints for buried pipe shall remain exposed until inspected. Where exposed pipe is in an area where vehicles need to cross, inspection process shall be expedited to minimize disruption in traffic flow.

C. Pipe and Tubing Support and Fastening Techniques:
1. Pipe and tubing shall be adequately supported per UPC and ASME requirements to prevent bending, sagging and excessive vibration or damage to threads or flanges. When placing pipe onto supports, care shall be exercised so as not to jerk pipe or impose any stresses that may kink or put a permanent bend or stress in pipe, or crack a thread.
2. As a minimum, clamps shall be placed no greater than 60 inches apart and 12 inches from both sides of any bends. Where requirements of any codes or manufacturer are more stringent, that clamping interval shall apply. Pipe and tubing shall not be used to support external devices. Clamps and fasteners shall be adequate for application intended.
3. Clamps and fasteners shall be secured by mechanical means (e.g. welded, bolt with lock washer). Use of adhesives and self-tapping screws shall be subject to Engineer's approval. Use of Swagelok or Stauff Tubing Support Systems (plastic saddle clamp type) is required for tubing and piping.
4. Clamp spacing shall be as per governing code or clamp manufacturer's specifications, whichever is more stringent. Unistrut style conduit clamps will not be acceptable for piping and tubing.

D. Identification:
1. Weld Identification: After completing a weld, welder shall mark it to identify work. Where two or more welders are employed to produce a single weld, joint shall be marked to identify portion made by each welder. No notch stencils shall be used. Paint sticks are acceptable, so long as identification will last until weld has been deemed satisfactory.
2. Pipe and Valve Identification:
a. Pipe Identification: Permanent labels with 1-inch high lettering indicating pressure and flow direction shall be permanently fastened to piping at 20-foot intervals.
b. Valve Identification: Manual and automated valves shall be equipped with stainless steel or brass labels with a unique valve number clearly indicated in 1/2-inch high letters and permanently affixed to valve with stainless steel wire or chain.

3.2 FIELD QUALITY CONTROL

A. Non-destructive Examination of Weld Joints:
1. All welds shall be visually examined for uniform appearance and finish.
2. Butt welds shall be subjected to 10 percent full circumference radiographic testing by a National Board (N.B.) certified agency or as required by governing code, whichever is greater. Acceptability of weld is based on ANSI B31.3. Radiographic test reports and films on shop-fabricated piping shall be forwarded to Owner at time of shipping. Testing shall include 10 percent of each welder's welds and 10 percent of each pipe size and thickness.
3. Pipe spool sketches referenced to each X-ray to allow later identification of a particular X-ray to a particular weld must be provided along with X-ray reports and films. Sketches must also identify welder who performed each weld.

4. Thread-o-lets and weld-o-lets must be die penetrant or mag particle tested.

B. Pressure Testing:
   1. General:
      a. Gas piping shall be pressure tested to a value of 1.5x (hydrostatic) relief valve setting for 60 minutes, or 1.1x (pneumatic) relief valve setting, or as required by local inspection agency. Extreme care shall be used due to inherent risk of a catastrophic failure that could cause serious injury. Non-essential personnel shall leave, and protection from injury shall be provided for those left on-site. Shop reports shall be signed by a Professional Engineer or piping contractor company executive and shall include:
         1) Spool number
         2) Spool description
         3) PSV pressure relief valve setting
         4) Test pressure(s)
         5) Test duration (starting and ending times)
         6) Test date
         7) Signature of Technician
         8) Calibration data for gages, meters, transducers, and telemetry equipment
         9) Ambient temperature
      b. Prior to performing tests, PSVs and filter cartridges shall be removed from system. Subsequent to pressure tests, PSVs and filter cartridges shall be reinstalled.
      c. Pressure testing shall be witnessed by Owner to confirm compliance with specified requirements.
   2. Hydrostatic Testing:
      a. Pipes shall be removed or isolated to prevent water from entering compressor or piping spools. Hydrostatic test shall be performed with clean water only. Pre-testing to approximately 60 psig is recommended, to locate major deficiencies. Subsequent pressure increases shall be made gradually to prevent "shocking" of pipe system, increasing pressure gradually to full test pressure (1.5 times SRV setting), and holding it for one hour.
      b. At end of test, a visual inspection of all joints (welded, threaded, compression and flanged) shall be made to determine if any visible leakage has occurred. Immediately after water has been fully drained from system, a high-velocity dry nitrogen purge shall be made throughout system until no water remains.
   3. Tie-ins: Piping or tubing tie-ins shall be removed from system and pressure tested in accordance with above requirements. After reinstallation, tie-ins shall be leak-tested at working pressure of system.
   4. Purging and Pressurizing:
      a. Purging and pressurizing shall be performed by Contractor and witnessed by Engineer or Owner’s Designate.
      b. Before pressurizing with natural gas commences, ESD system shall be tested and fully operational. Natural gas shall not be introduced into system without prior approval of local gas utility and express authorization of Engineer. Air shall be purged from entire system to satisfaction of Engineer prior to pressurizing system.
      c. Before natural gas is introduced into any piping system, fabrication, testing and work requiring flame or sparking devices shall be complete. After natural gas has been introduced, welding or work which could ignite natural gas vapors shall be performed only upon express authorization by Owner on a case-by-case basis.
   5. Leak Test:
      a. Subsequent to final field installation and pressure tests, completed piping with valves in place shall be leak-tested before being placed in operation, to ensure that it does not leak.
      b. Piping and tubing shall be pressurized with natural gas to its normal operating pressure (4500 psig downstream of CNG compressors) and tested with a suitable liquid leak detector such as "Snoop" (by Swagelok Company).
      c. The following locations shall be tested:
         1) Flanged joints.
         2) Threaded joints.
         3) Tube joints.
         4) Accessible butt joints.

3.3 CLEANING

A. Pipe and Tube Cleaning:

1. Subsequent to pipe fabrication and testing, pipe shall be mechanically cleaned with wire brushes and/or swabs or pigs, followed by internal cleaning with a non-residual, degreasing and slag-removing solution. A high-velocity dry nitrogen purge shall be made to remove any loose scale, fillings, water or foreign material. Once slag, mill oil, and cleaning solution has been removed, piping shall be coated internally (within 24 hours of cleaning) with a light coating of synthetic oil used in compressor. (Dryer piping is exempted from this requirement, but must be shipped with 15 psig dry nitrogen charge with a gauge and sealed valve.)
2. Subsequent to tubing fabrication, a high-velocity nitrogen purge shall be made to remove any loose scale, filings, water or foreign material.

END OF SECTION

SECTION 400541
CNG PIPE HANGERS, SUPPORTS AND ANCHORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. System of pipe supports with necessary bolts, nuts, washers, miscellaneous steel, and other accessories.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Pipe support system components shall withstand dead loads imposed by weight of pipes plus live loads due to thermal expansion, vibration, internal test pressures, and have minimum safety factor of 5.
   2. Absence of pipe supports and details on drawings shall not relieve Contractor of responsibility for providing them throughout facility and site.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Pipe supporting system, including manufacturer's product data, dimensions, sizes, types, location, maximum loadings, thrust anchorage, and installation instructions.
   2. Provide (1) reproducible and (1) print.

B. Submit in accordance with Section 013300.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Metal Framing Systems:
   1. Fee and Mason.
   2. Unistrut.
   3. Superstrut.
   4. Or equal.

2.2 MATERIALS

A. Supports, clamps and metal framing channels shall be Type 316 stainless steel.

2.3 HORIZONTAL PIPING SUPPORTS

A. Steel support stand with metal framing channel for attachment of pipe clamps.

B. Pipe Clamp: Two piece clamp with top bolted connection designed to insert into to metal framing channel.

2.4 HORIZONTAL TUBING SUPPORTS

A. Metal framing channel for attachment of tube clamps.

B. Tube Clamp: Two piece clamp with foam plastic insert insulating tube from clamp and top bolted connection designed to insert into to metal framing channel.

2.5 MISCELLANEOUS MATERIALS

A. Shop-fabricated Anchors and Supports:
   1. Steel Plates, Shapes and Bars: ASTM A36/A36M.

2. Fabricate in accordance with Section 055000.

PART 3 EXECUTION

3.1 GENERAL

A. Except as otherwise indicated for exposed continuous pipe runs, install supports of same type and style as installed for adjacent similar piping.

B. Do not support piping from other piping.

C. Prevent contact between dissimilar metals. Where concrete or metal pipe support is used, place 1/8-inch thick teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and support.

D. Apply anti-seize compound to nuts and bolts.

3.2 PIPE SUPPORT

A. Spacing:

Type of Pipe or Tube	Maximum Pipe Support Spacing (ft.)
STEEL PIPE	
6 in.	17
5 in.	16
4 in.	14
3-1/2 in.	13
3 in.	12
STAINLESS STEEL TUBE	
3/4 in.	4-1/2
1/2 in.	4-1/2
1/4 in.	2-1/2

B. Where piping of various sizes is to be supported together, space supports for smallest pipe size, or install intermediate supports for smaller diameter pipe.

C. Provide minimum of (2) pipe supports for each pipe run.

D. Where piping connects to equipment, support by pipe support and not by equipment, unless approved by equipment manufacturer.

E. Unless otherwise shown or authorized by Engineer, place piping running parallel to walls approximately 1-1/2 inches out from face of wall, and at least 3 inches below ceiling.

F. Support piping in manner preventing undue strain on valve, fitting, or equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise shown.

G. Install supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Piping shall be free to move when it expands or contracts, except where fixed anchors are indicated. Where adequate hanger rod swing length cannot be provided, or where pipe movement based on expansion of 1-inch/100-feet for each 100°F change in temperature exceeds 1/2-inch, provide approved roller supports.

I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

END OF SECTION

SECTION 402200
PNEUMATIC LUBE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pumps
   2. Hose Reels
   3. Control Handles
   4. Piping

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate electrical and piping connections with equipment being provided.

PART 2 PRODUCTS

2.1 PUMPS - LIGHT LUBRICANT (HYDRAULIC, TRANSMISSION, ENGINE OIL, SYNTHETIC OIL)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Graco 225-640 OR EQUAL
   2. Other manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to pump schedules

C. Description:
   1. PUMP TO BE 55 GALLON DRUM LENGTH. 5:1 RATIO, MEDIUM PRESSURE, PNEUMATICALLY OPERATED, DOUBLE BALL, DOUBLE ACTING, POSITIVE DISPLACEMENT PUMP.
   2. PUMP TO HAVE 3" DIAMETER AIR MOTOR WITH A 3" STROKE. AIR MOTOR TO BE BALANCED WITH NO METAL TO METAL SEALS.
   3. THE AIR MOTOR, AIR MOTOR VALVES, AND LOWER PUMP ARE TO BE OF THE IN-LINE DESIGN.
   4. AIR CYLINDER MATERIAL IS TO BE ALUMINUM AND CORROSIVE RESISTANT STEEL.

5. NORMAL AIR REQUIREMENTS ARE 40 TO 180 P.S.I. WITH AIR CONSUMPTION OF 7.5 C.F.M. PER GALLON PUMPED. MAXIMUM FLUID PRESSURE OF 900 P.S.I.
6. THE AIR MOTOR WILL INCLUDE A MUFFLING SYSTEM THAT ENABLES THE PUMP TO OPERATE BELOW THE PRESCRIBED O.S.H.A. NOISE STANDARDS.
7. TO PROLONG THE LIFE OF THE PUMP PACKING, THE PUMP SHALL HAVE ADJUSTABLE THROAT PACKING NUT.
8. PUMP TO HAVE INTEGRAL GROUNDING LUG TO PREVENT STATIC ELECTRICITY.
9. THE ENTIRE PUMP TO HAVE *30 YEAR WARRANTY AGAINST MANUFACTURING DEFECTS, WORKMANSHIP AND DESIGN* ON HARD PARTS WITH *COMPLETE FIVE (5) YEAR GUARANTEE ON PARTS AND LABOR.*
10. ALSO INCLUDES 6' AIR AND FLUID HOSE KIT WITH SWIVEL CONNECTIONS.

D. Accessories
1. Provide a 3/8” air regulator with gauge.
   a. Graco 109-075 or equal
2. Provide a thermal relief kit
   a. Graco 237-893 or equal
3. Provide a low level cut-off
   a. Graco 203-688 or equal
4. Provide a ½” fluid shut off valve
   a. Graco 108-458 or equal
5. Provide a ½” air shut off valve
   a. Graco 107-142 or equal

2.2 PUMPS - GREASE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Graco 225-016 OR EQUAL
2. Other manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to pump schedules

C. Description:
1. PUMP TO BE 400 POUND DRUM LENGTH. 50:1 RATIO, HIGH PRESSURE, PNEUMATICALLY OPERATED, DOUBLE ACTING POSITIVE DISPLACEMENT SHOVEL PUMP.
2. PUMP TO HAVE 3" DIAMETER AIR MOTOR WITH A 3" STROKE. AIR MOTOR TO BE BALANCED WITH NO METAL TO METAL SEALS.
3. THE AIR MOTOR, AIR MOTOR VALVES, AND LOWER PUMP ARE TO BE OF THE IN-LINE DESIGN.
4. AIR CYLINDER MATERIAL IS TO BE ALUMINUM AND CORROSIVE RESISTANT STEEL.
5. NORMAL AIR REQUIREMENTS ARE 40 TO 160 P.S.I. WITH AIR CONSUMPTION OF 3 C.F.M. PER GALLON PUMPED. MAXIMUM FLUID PRESSURE OF 8000 P.S.I.
6. THE AIR MOTOR WILL INCLUDE A MUFFLING SYSTEM THAT ENABLES THE PUMP TO OPERATE BELOW THE PRESCRIBED O.S.H.A. NOISE STANDARDS.
7. TO PROLONG THE LIFE OF THE PUMP PACKING, THE PUMP SHALL HAVE ADJUSTABLE THROAT PACKING NUT.
8. PUMP TO HAVE INTEGRAL GROUNDING LUG TO PREVENT STATIC ELECTRICITY.
9. THE ENTIRE PUMP TO HAVE 30 YEAR WARRANTY AGAINST MANUFACTURING DEFECTS, WORKMANSHIP AND DESIGN ON HARD PARTS WITH COMPLETE FIVE (5) YEAR GUARANTEE ON PARTS AND LABOR.
10. ALSO INCLUDES DRUM COVER AND AIR AND FLUID HOSE KIT.

D. Accessories
1. Provide a 3/8” air regulator with gauge.
   a. Graco 109-075 or equal
2. Provide a ½” air shut off valve
   a. Graco 107-142 or equal
3. Provide a high pressure grease on/off needle feathering valve
   a. Graco 202-869 or equal.

2.3 PUMPS – DIESEL COOLANT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Graco 244-680 OR EQUAL – AIR OPERATED BULK TRANSFER PACKAGE.
   2. Other manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to pump schedules

C. Description:
   1. 647-016 *HUSKY 1050* 1" DOUBLE DIAPHRAGM ALUMINUM PUMP OR EQUAL.
      a. 1:1 RATIO, 50 GPM, 120 MAX. PSI
      b. 1/2" AIR INLET, 1" FLUID INLET/OUTLET

D. Accessories:
   1. AIR REGULATOR, FLUID & AIR CONNECTING HOSES, AIR SHUT-OFF VALVE, WALL BRACKET, SUCTION KIT AND THERMAL RELIEF KIT.

2.4 HOSE REELS – LIGHT LUBRICANTS (HYDRAULIC, TRANSMISSION, ENGINE OIL, SYNTHETIC OIL)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Graco HSM-C8B XD SERIES SIZE 30 OPEN STYLE OIL REEL.OR EQUAL
   2. Other manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to hose reel schedules

C. Description:
   1. HEAVY DUTY, LARGE CAPACITY SPRING POWERED. REEL TO HAVE 1/4" STEEL BASE, 7 GAUGE STEEL PEDESTAL SUPPORT, AND 7 GAUGE DOUBLE REEL SUPPORT GUSSET, WITH 16 GAUGE STEEL REEL FLANGE.
   2. REEL TO HAVE MACHINED SHAFT WITH MINIMUM PORTING OF 1/2" AND TO INCLUDE OIL-LITE BEARING AND CAST STEEL RACHET ASSEMBLY.
   3. REEL TO HAVE FOUR (4) REPLACEABLE ALL WEATHER ROLLER GUIDES MOUNTED ON A 270 DEGREE ADJUSTABLE ARTICULATING HOSE GUIDE HEAD.
   4. SUPPORT ARMS FOR REEL TO BE ADJUSTABLE FOR WALL, FLOOR OR OVERHEAD MOUNTING AND REEL TO HAVE A THREE (3) YR COMPLETE WARRANTY.
   5. TO INCLUDE 75' x 1/2" HOSE WITH BALL STOP. BLUE PAINT.

D. Accessories:
   1. Provide a ½" fluid shut off valve
      a. GRACO 108-458 OR EQUAL.
   2. Provide a 2' x ¾" inlet hose kit
      a. GRACO 24E-284 OR EQUAL.

2.5 HOSE REELS – GREASE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. GRACO HSH-C5B XD SERIES SIZE 30 OPEN STYLE GREASE REEL OR EQUAL.
   2. Manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to hose reel schedules

C. Description:
   1. HEAVY DUTY, LARGE CAPACITY SPRING POWERED. REEL TO HAVE 1/4" STEEL BASE, 7 GAUGE STEEL PEDESTAL SUPPORT, AND 7 GAUGE DOUBLE REEL SUPPORT GUSSET, WITH 16 GAUGE STEEL REEL FLANGE.
   2. REEL TO HAVE MACHINED SHAFT WITH MINIMUM PORTING OF 1/2" AND TO INCLUDE OIL-LITE BEARING AND CAST STEEL RACHET ASSEMBLY.

3. REEL TO HAVE FOUR (4) REPLACEABLE ALL WEATHER ROLLER GUIDES MOUNTED ON A 270 DEGREE ADJUSTABLE ARTICULATING HOSE GUIDE HEAD.
4. SUPPORT ARMS FOR REEL TO BE ADJUSTABLE FOR WALL, FLOOR OR OVERHEAD MOUNTING AND REEL TO HAVE A THREE (3) YR COMPLETE WARRANTY.
5. TO INCLUDE 50' x 1/2" HOSE WITH BALL STOP. BLUE PAINT.

D. Accessories:
1. Provide a high pressure grease on/off needle feathering valve
   a. Graco 202-869 or equal.
2. Provide a 2' x 1/2" inlet hose kit
   a. GRACO 24E-283 OR EQUAL.

2.6 HOSE REELS – COOLANT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. GRACO HSL-C8B XD SERIES SIZE 30 OPEN STYLE WATER REEL OR EQUAL.
2. Manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to hose reel schedules

C. Description:
1. HEAVY DUTY, LARGE CAPACITY SPRING POWERED. REEL TO HAVE 1/4" STEEL BASE, 7 GAUGE STEEL PEDESTAL SUPPORT, AND 7 GAUGE DOUBLE REEL SUPPORT GUSSET, WITH 16 GAUGE STEEL REEL FLANGE.
2. REEL TO HAVE MACHINED SHAFT WITH MINIMUM PORTING OF 1/2" AND TO INCLUDE OIL-LITE BEARING AND CAST STEEL RACHET ASSEMBLY.
3. REEL TO HAVE FOUR (4) REPLACEABLE ALL WEATHER ROLLER GUIDES MOUNTED ON A 270 DEGREE ADJUSTABLE ARTICULATING HOSE GUIDE HEAD.
4. SUPPORT ARMS FOR REEL TO BE ADJUSTABLE FOR WALL, FLOOR OR OVERHEAD MOUNTING AND REEL TO HAVE A THREE (3) YR COMPLETE WARR.
5. TO INCLUDE 75' x 1/2" HOSE WITH BALL STOP. BLUE PAINT.

D. Accessories:
1. Provide a ½" fluid shut off valve
   a. GRACO 108-458 OR EQUAL.
2. Provide a 2' x ¾" inlet hose kit
   a. GRACO 24E-284 OR EQUAL.

2.7 CONTROL HANDLES – LIGHT LUBRICANTS (HYDRAULIC, TRANSMISSION, ENGINE OIL, SYNTHETIC OIL)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. GRACO OR EQUAL.
2. Manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to control handle schedules

C. Description:
1. GRACO 255-200 OR EQUAL. ELECTRONICALLY METERED PRE-SET DISPENSE VALVE. FIVE YEAR WARRANTY. INCLUDES VALVE WITH INLET FILTER, INLET SWIVEL, ELECTRONIC METERED TOTALIZING METER THAT CAN BE SET FOR PINTS, QUARTS OR GALLONS INCREMENTS. ALSO INCLUDES *RIGID* EXTENSION TUBE AND STANDARD AUTOMATIC NON-DRIP QUICK CLOSE NOZZLE. ACCURACY OF +OR - .5% BY VOLUME. FLOW RATE OF 5 GPM. NO SEALS, PERMANENT MEMORY FOR TOTALIZATION. NON DIRECTIONAL FLOW. DISPENSE VALVE TO HAVE SCREW-TIGHT NOZZLE FOR POSITIVE SHUT OFF.

2. GRACO 255-351 OR EQUAL. ELECTRONICALLY METERED PRE-SET DISPENSE VALVE. FIVE YEAR WARRANTY. INCLUDES VALVE WITH INLET FILTER, INLET SWIVEL, ELECTRONIC METERED TOTALIZING METER THAT CAN BE SET FOR PINTS, QUARTS OR GALLONS INCREMENTS. ALSO INCLUDES *FLEX* EXTENSION TUBE AND STANDARD AUTOMATIC NON-DRIP QUICK CLOSE NOZZLE. ACCURACY OF +OR - .5% BY VOLUME. FLOW RATE OF 5 GPM. NO SEALS, PERMANENT MEMORY FOR TOTALIZATION. NON DIRECTIONAL FLOW. DISPENSE VALVE TO HAVE SCREW-TIGHT NOZZLE FOR POSITIVE SHUT OFF.

D. Accessories:
   1. Provide a meter inlet swivel cover - Red
      a. GRACO 15T-367 OR EQUAL
   2. Provide a meter inlet swivel cover - Blue
      a. GRACO 15T-368 OR EQUAL
   3. Provide a meter inlet swivel cover - Yellow
      a. GRACO 15T-370 OR EQUAL

2.8 CONTROL HANDLES – COOLANT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. GRACO OR EQUAL.
   2. Manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to control handle schedules

C. Description:
   1. GRACO 255-356 OR EQUAL. ELECTRONICALLY METERED PRE-SET DISPENSE VALVE. FIVE YEAR WARRANTY. INCLUDES VALVE WITH INLET FILTER, INLET SWIVEL, ELECTRONIC METERED TOTALIZING METER THAT CAN BE SET FOR PINTS, QUARTS OR GALLONS INCREMENTS. ALSO INCLUDES FLEX EXTENSION TUBE AND STANDARD QUICK CLOSE NOZZLE. ACCURACY OF +OR - .5% BY VOLUME. FLOW RATE OF 5 GPM. NO SEALS, PERMANENT MEMORY FOR TOTALIZATION. NON DIRECTIONAL FLOW. DISPENSE VALVE TO HAVE SCREW-TIGHT NOZZLE FOR POSITIVE SHUT OFF.

D. Accessories:
   1. Provide a meter inlet swivel cover - Green
      a. GRACO 15T-369 OR EQUAL

2.9 CONTROL HANDLES – GREASE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. GRACO 242-058 OR EQUAL. PRO-SHOT NON-METERED DISPENSE VALVE.
   2. Manufacturers must be submitted to engineer prior to bidding for acceptance and must meet the criteria listed in the specifications and schedules.

B. Capacities and Characteristics: Refer to control handle schedules

C. Description:
   1. INCLUDES VALVE WITH 3/8" NPT(F) INLET, COUPLER AND EXTENSION #200-389.
   2. HIGH PRESSURE VALVE WITH KNURLED-GRIP BODY.
   3. MAXIMUM WORKING PRESSURE : 8000 PSI.
   4. CARRIES A FIVE (5) YEAR WARRANTY.

D. Accessories:
   1. Provide a meter inlet swivel cover - Green
      a. GRACO 15T-369 OR EQUAL

2.10 PIPING – LIGHT LUBRICANTS

A. ¾” o.d. x 0.049” wall thickness annealed steel tubing.

2.11 PIPING – CHASSIS GREASE

A. 5/8” o.d. x 0.109” wall thickness annealed steel tubing.

2.12 PIPING – COOLANT

A. ¾” o.d. type N copper.

B. ¾” o.d. x 0.025” wall thickness stainless steel annealed tubing.

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps, hose reels and control handles per manufacturer’s recommendations.

3.3 CONNECTIONS

A. Install piping adjacent to pumps to allow service and maintenance.

3.4 ELECTRICAL CONNECTION

A. Grounding connections for pumps and hose reels to be installed per manufacturer’s requirements. All electrical work should be performed by a licensed electrician.

3.5 IDENTIFICATION

A. Comply with requirements for identification specified in Division 22 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

SECTION 408010
SYSTEM DEMONSTRATIONS

PART 1 GENERAL

1.1 DESCRIPTION

A. Before Substantial Completion is considered for entire Work, Contractor shall test and demonstrate specific items of equipment and system in operation. Conduct testing and operation demonstrations on following system:

1. CNG Fueling System at Northwest Garage, per Sections 400100 and 400500.

B. Preliminary:

1. Before Contractor begins testing and system operation demonstrations, Installation Services specified in Section 016010 for system or equipment shall be completed.

C. All references to equipment and materials either furnished by or provided by ANGI is to be interpreted as being the basis of design and not sole source specified. Engineer and Owner preapproved equivalent products will be accepted, see Section 016210 for substitute requests. Basis of design for all equipment in this Section is the following:

1. ANGI Energy Systems, Inc. (ANGI), 15 Plumb Street, Milton, WI 53563, 800-955-4626, Dan Hicks, DHicks@angienercy.com, www.angiinternational.com
2. AssetWorks, 998 Old Eagle School Road, Wayne, PA 19087, Joseph A. Basile, VP Fueling Technologies, Joseph.basile@assetworks.com, 610-228-0120, and Jill Coffin, Jill.Coffin@assetworks.com, 610-228-0126.

D. Coordination:

1. Designate representative of Contractor to be responsible for testing and operation demonstration of system.
2. Notify Owner and ANGI at least two (2) weeks before tests and system operation demonstrations are to be given, so Owner can make arrangements for witness testing and demonstration.
3. Reschedule cancelled tests and operation demonstrations 5 days in advance.

1.2 SUBMITTALS

A. Reports:

1. Testing of Components and System:
   a. Prepare report for each system on results and activities encompassing testing as required by this Section. Submit report within (2) days of completion of tests.
   b. As a minimum, report shall describe findings of inspections; revisions, modifications or replacement of equipment; calibrations; test results; dates and names of persons involved and observing inspections, testing, and other activities pertaining to components and system; and a statement regarding operational condition of components and system.
2. System Operation Demonstration:
   a. Prepare report for system from results of activities encompassing operation demonstration as required by this Section. Submit report within (2) days of completion of 120-hour demonstration.
   b. Report shall describe operational conditions; daily results of system operation; dates and names of persons involved and observing operation; and a statement regarding system ability to meet operational criteria.

B. Submit in accordance with Section 013300.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 TESTING OF SYSTEM COMPONENTS

A. Subject each system, process, mechanical, instrumentation, and electrical equipment components, including related piping and control systems, to individual inspection and testing by Contractor and certified by Contractor to be ready for operations before beginning system operation demonstration.

B. Inspection and tests shall be made to determine if equipment is properly assembled, aligned, adjusted, calibrated, wire or connected. Changes, adjustments or replacements of equipment due to errors or omissions on the part of the Contractor, or otherwise necessary to comply with the requirements of the Contract Documents, shall be done without additional cost to the Owner.

3.2 SYSTEM OPERATION DEMONSTRATION

A. Upon completion of inspection and testing of individual components in the system, demonstrate operation and performance of the system for 120 hours in accordance with requirements of Contract Documents.
   1. Where no specific performance requirements are state in specifications, demonstrate to show that equipment operates in accordance with acceptable industry standards for application of equipment.
   2. System operation demonstration shall show that equipment operates within manufacturer's tolerances for noise and vibration, that equipment is responsive to manual and automatic controls, that control and protective devices are properly set, and that equipment runs on controlled or intermittent basis, when such operation is intended.
   3. System operation demonstration shall include checkout from each remote control point. Demonstrate alarm and safety lockout systems for proper function and process instrumentation and control.

B. During testing and system operation demonstration, Contractor shall arrange for presence of qualified representatives of suppliers of each piece of equipment and instrumentation included in the system, who are necessary to conduct test and demonstration.

C. Temporary facilities and services are Contractor's responsibility. Electrical power for equipment inside existing buildings will be supplied by Owner. Contractor shall provide temporary connections, if necessary.

D. Successful completion of system demonstration for the system will be when performance requirements established in the Contract Documents are met, while running for 120 consecutive hours.

E. If, during demonstration, the system is not meeting performance requirements established in Contract Documents, Contractor shall stop demonstration and adjust, calibrate, or replace equipment or instrumentation, and restart and run demonstration until 120 consecutive hours have been completed.

3.3 DETERMINATION OF SUBSTANTIAL COMPLETION

A. Systems Described in Section:
   1. Upon successful completion of testing of system components, system operation demonstrations, and delivery of submittals specified in this Section, the Contractor shall notify Owner and Engineer in writing that components and system are substantially complete.

B. Other Systems:
   1. Other identified systems will be considered for Substantial Completion when Contractor considers Work ready for its intended use.
   2. Components and systems will be substantially complete after successful completion of testing of components and systems, system operation demonstration, and delivery of submittals.

END OF SECTION

SECTION 409010
GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General requirements for package and non-package Instrumentation and Control Systems, unless otherwise specified in other sections.

1.2 DEFINITIONS

A. Selector Switch: When used under panel component, description refers to maintained contact type switches. Loss and return of control power to circuit does not change control mode of requirements in switch position.

B. Push-button: When used under panel component, description refers to momentary contact type switches which, unless specified otherwise, shall require electrical interlock. Loss of control power shall, unless specified otherwise, result in loss of electrical interlock and stoppage of previous mode of operations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Provide run/fail, alarm, and equipment status functions.
   2. Unless otherwise specified, "run" signals shall be derived from motor starter normally open auxiliary contacts.
   3. Unless otherwise specified, discrete input and output signals shall conform to:
      a. Isolated unpowered (dry) contact closures.
      b. Power contact from panel receiving signal or device receiving signal.
   4. Unless otherwise specified, input and output analog signals shall conform to:
      a. 4-20 mAdc.
      b. For 2-wire transmitter, provide isolated type and power with 24 or 48 vdc at panel or device receiving signal.
      c. Where isolation is required to interface with particular equipment furnished, provide necessary I/I converters.
   5. For PLC based systems, manual control devices in panel or field shall be independent from PLC, to provide maintenance and redundancy function.
   6. Panels, panel devices, and field devices shall meet or exceed NEMA requirements as follows:
      a. NEMA 4X: Wet locations or outdoors.
         1) Instrumentation and control panels shall be 316 stainless steel.
         2) Instruments and device enclosures shall be 316 stainless steel, fiberglass, or ABS plastic.
      b. NEMA 7: Class I, Division 1 or 2 areas.
      c. NEMA 12: Other areas.
   7. Design Life: Design control system for minimum 10-year life at the following temperatures:
      a. Permit continuous operation with panel external ambient temperatures of up to +40°C (+104°F).
      b. Outdoor Panels: Permit operation with panel external ambient temperatures of down to -29°C (-20°F).
      c. Indoor Panels: Permit operation with panel external ambient temperatures of down to +8°C (+40°F).
   8. When motor controller disconnecting means is off, de-energize associated equipment devices powered from panel.
   9. Electrical wiring and controls shall conform to Division 26.

B. Identify equipment on panel or screens with indication below:
   1. Green Light On: Equipment running.

2. Red Light On: Equipment failure when called to run, but not running due to power failure, overload, breaker, disconnect, or remote switch call for equipment to stop.
    a. Provide parallel "required" contact wired to panel for items such as pumps and valves.
    b. Provide necessary relay logic and adjustable timers to sense discrepancy between "required" and "running," and activate respective "Run" and "Fail" light from these signals. Provide horn when specified.
3. Amber Light On: Indicates equipment status, such as valve open or closed.
4. White Light On: Equipment off.

1.4 SUBMITTALS

A. General:
1. Submit the following information tabulated in booklet form for each piece of equipment or system furnished under this Section.
2. Table of Contents of Submittals: Include for each booklet when more than one item of equipment is included in submittal:
    a. Engineer’s instrument tag number.
    b. Instrument manufacturer’s model number.
    c. Related piping, electrical and dimension drawings.

B. Product Data:
1. Construction materials.
2. Ranges.
3. Output/Input signals.
4. Accessories.
5. Mounting location.
6. Engineer’s tag number on manufacturer’s specifications sheets.
7. Interconnect reference for associated field and panel instruments.
8. Component specification sheets.

C. Shop Drawings:
1. Panel fabrication and dimension drawings, nameplate legends, Engineer’s tag numbers, and wiring and piping schematic drawings. Project specific drawings are required for each panel; typical are not acceptable.
2. Equipment dimension drawings.
3. Equipment terminal and piping connections.
4. Loop-by-loop system electrical schematic showing terminal-to-terminal interconnections between related panel and field instruments.
5. Front of panel layout.
6. PLC I/O module connection diagram for PLC-based systems.
7. Ladder/logic system electrical schematic showing wiring of each component, including ranges and set points. Wiring and ladder diagram shall have reference numbers on every line for cross- referencing. Each device on ladder shall be cross-referenced with line number to wherever it is located.
8. Terminal-to-terminal interconnection drawings showing wiring for panel-to-panel/MCC, and panel to field equipment.

D. Miscellaneous:
1. Certificate of UL or nationally recognized testing laboratory (NRTL) inspection and approval for each completely assembled panel prior to shipment to Project site.
2. Include Engineer’s tag number, when available, on each submittal document or page wherever specific component appears.
3. Extra materials list.

E. Operation and Maintenance (O&M) Data:
1. Include O&M data for each panel and field device specified in Division 40:
    a. PLC ladder logic software (electronic and printed) including tags, comments, operational database values, and passwords or pass codes.
    b. Configured software on electronic media to install program on spare PLC processors and programmable controller.

c. Bill of materials.
d. Instruction Manual: Includes detailed operating sequence descriptions.
e. Maintenance Manual: Instructions for maintaining equipment to include calibrating, cleaning, and troubleshooting.
f. Front and rear panel layout drawings.
g. Nameplate data.

2. Submit (1) package:
a. Equipment provided under Section 409015.

F. Submit in accordance with Section 013300.

1.5 QUALITY ASSURANCE

A. Standardization:
1. Drawings and Specifications are intended to provide overall system functions. Provide equipment necessary to provide complete and operable system.
2. Contractor is responsible for costs resulting from deviations from Contract Documents.

B. Items provided under Specification Sections referred to in this section shall be listed or labeled by UL or other National Recognized Testing Laboratory (NRTL).
1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC, Article 100).

C. Regulatory Requirements:
1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 PRODUCTS

2.1 EQUIPMENT MARKERS

A. Furnish equipment markers with Engineer’s equipment name and tag number.

2.2 SOURCE QUALITY CONTROL

A. Perform UL inspection and certification for each completely assembled panel before shipment to project site.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment in locations indicated on drawings and in accordance with manufacturer’s written instructions and approved submittals.

3.2 EQUIPMENT MARKERS

A. Fasten to equipment to be visible.

END OF SECTION

SECTION 409015
INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General provisions and requirements for instrumentation and control equipment and systems.

1.2 DEFINITIONS

A. Systems House: Supplier whose principle function is design, manufacture, and service of instrumentation and control (I&C) systems.

1.3 SYSTEM DESCRIPTION

A. Instrumentation and control package for plant process control. Does not include process equipment package panels.

1.4 QUALITY ASSURANCE

A. Standardization:
   1. Instrumentation and Control System shall be provided by single Systems House.
   2. Equipment shall be the latest model or version available at the time bids are opened, unless otherwise noted.
   3. When more than one I&C equipment component of like function is required, end products shall be of single manufacturer to achieve standardization for maintenance, spare parts, operation, and service.
   4. Maintain consistent front of panel layout for panels.
   5. Systems House shall coordinate data highway communication with process package systems.

B. Experience:
   1. Systems House shall have at least (5) years' experience in design, manufacture, installation, and successful operation of instrumentation systems similar to specified.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Equipment provided under this section includes:
   1. Panel and Field Devices: Section 409514.
   2. Instrumentation and Control Panels: Section 409040.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install and wire in accordance with manufacturer's written instructions and approved submittals.

B. Wire instrumentation and control package panels specified in Division 40.

C. Wire components specified in Division 40.

3.2 FIELD QUALITY CONTROL

A. System's House/Manufacturer's Field Services:

1. Manufacturer's engineer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than process design and philosophy. See Section 01600.
2. Provide services of qualified service engineer to supervise and inspect equipment installation to ensure that system is installed in accordance with manufacturer's recommendations.
3. Field-calibrate equipment at time of complete system startup on a loop-by-loop basis. Document filed calibration results for each piece of equipment and provide to Owner.
4. Make adjustments necessary to place equipment in satisfactory operation.
5. Manufacturer's engineer for equipment specified shall be present at job site or classroom designated by Owner for man-days indicated (travel time excluded), for assistance during plant construction, plant startup, equipment adjustment, and training of Owner's personnel for plant operation. Include minimum of:
    a. Instrumentation and Control Panels, Section 409040:
        1) One (1) man-day for Installation Services.
        2) 1/2 man-day for Instructional Services.
        3) One (1) man-day for Post Startup Services.

END OF SECTION

SECTION 409040
INSTRUMENTATION AND CONTROL PANELS

PART 1 GENERAL

1.1 SUMMARY

A. Section, in conjunction with P&IDs, describes I&C panels and remote devices.

1.2 DEFINITIONS

A. Abbreviations:
   1. PLC: Programmable Logic Controller.
   2. OIU: Operator Interface Unit.
   3. LCP: Local Control Panel.

PART 2 PRODUCTS

2.1 INSTRUMENTATION AND CONTROL (I&C) EQUIPMENT

A. Equipment provided in this section shall conform to the following:
   1. General Provisions for Instrument and Control, Section 409010.
   2. Instrument and Control Panel Construction, Section 409513.
   3. Data Communications Network Components, Section 409033.
   4. Data Communications Cabling, Section 409534.

2.2 NETWORK DESCRIPTION

A. Provide Ethernet connections from equipment shown on Network Diagram using fiber optic cable, CAT5E, or Ethernet Extension Cable as shown.

B. Provide CNG equipment network between Owner-provided equipment using cable as shown on Network Diagram.

2.3 EXISTING COMMUNICATIONS PANEL (02-LCP-03)

A. Existing Panel:
   1. NEMA 4.
   2. Unistrut Mounting.
   3. 120 vac power supply.
   4. Lockable Door.
   5. Rain Shield.

B. Front of Panel Mounted Devices: None.

C. Rear of Panel Mounted Devices:

Designation	Description/Range	Interface
Ethernet Switch	Furnished by DPW to be mounted by Contractor	Ethernet field devices and building office
Patch Panel	12 core fiber optic patch panel	Fiber optic cable
Surge Protections Ethernet	Surge protection each copper Ethernet CAT5E cable	--

D. Additional Panel Equipment/Requirements:
   1. DPW will provide management and setup of Ethernet Switch.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install and wire in accordance with manufacturer's written instructions and approved submittals.

3.2 FIELD TESTING

A. Preparation:
   1. Schedule field testing that affects plant operation through Owner 48 hours before testing.
   2. Resolve interface discrepancies.
   3. Maintenance:
      a. Perform maintenance on equipment throughout course of Work.
      b. Perform preventative maintenance in accordance with manufacturer's recommendations.
      c. Keep maintenance records with equipment and make records available for examination during Work.
      d. Test each communications link with Owner and Owner-provided equipment supplier.

END OF SECTION

SECTION 409514
PANEL AND FIELD DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Comply with Section 409010.

PART 2 PRODUCTS

2.1 PUSH-BUTTON/SELECTOR SWITCH CONTROL UNITS AND PILOT LIGHTS

A. Manufacturers:
   1. Square D.
   2. Cutler-Hammer.
   3. Allen-Bradley.
   4. Or equal.

B. Construction:
   1. Heavy duty.
   2. Oil-tight, watertight.
   3. Base mounting.
   4. Flush panel mounting.
   5. Size to mount in 30.5 mm opening without adapter. Smaller units are not acceptable.

C. Emergency Stop Device (ESD) in NEMA 4X Stainless Steel Control Station:
   1. Jumbo red mushroom head.
   2. Contact Blocks:
      a. Double break silver contacts.
      b. ac Ratings: 7,200 va make, 720 va break.
      c. Single pole, double throw or double pole, single throw.
      d. Up to 2 tandem blocks.
   3. Push/Pull
   4. Maintained contact.
   5. Non-illuminated.
   6. Padlock attachments constructed of metal. Plastic material is not acceptable.
   7. Legend Plates:
      a. Extra large.
      b. Red.
      c. Emergency Stop.

D. Nameplates:
   1. I&C Panel: Section 409513.
   2. Control Stations:
      a. Engraved laminated plastic.
      b. Letters 3/16 inch high.
      c. Black letters on white background.
      d. Identify per equipment controlled.

2.2 TERMINAL BLOCKS FOR CONTROL WIRING

A. Manufacturers:
   1. Phoenix Contact. UK-5N.
   2. Allen Bradley, Bulletin 1492.

B. General:
   1. 600 v rating.
   2. Marker labels on each terminal.

3. Clip-mount on DIN rails.
4. Insulating end caps to support each terminal block assembly.
5. Touchsafe terminal block and accessories.
6. Connection: Captive screw and pressure plate. Connection shall not cause deformation of wire.
7. Contact material and surface: Nickel or tin-plated copper alloy. Do not use ferrous metals.

C. Switched Knife Disconnect (when specified):
1. Non-fused.
2. Single-pull, single-throw (SPST).
3. Hinged disconnect lever.

D. Fused Indicating (when specified):
1. LED blown fuse indicating light.
2. Hinged disconnect lever.
3. Size fuse for load.
4. 15 amp capacity fuse holder.

2.3 TAGGING

A. Provide Type 316 stainless steel tag on field-mounted units and permanently affix tag to unit.

B. Engrave with process application as listed in Specifications.

C. Include Engineer's tag number as listed in Specifications and on P&IDs.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA "Standard of Installation," and recognized industry practices.

B. Control Relays:
1. Provide control relays for general purpose logic circuits.
2. Provide motor starter control relays when load exceeds rating of general purpose control relays.

END OF SECTION

SECTION 409533
DATA COMMUNICATIONS NETWORK COMPONENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Local area, Ethernet, and control system network components.
   2. Networks indicated on the drawings and specified – include network connections, equipment locations, hardware requirements and performance. Contractor is responsible for providing all components necessary for a complete operating system.

1.2 DEFINITIONS

A. Patch Cable: Cables that are used for connecting Ethernet components within a room or enclosure.

1.3 SYSTEM DESCRIPTION

A. See Section 409040 and drawings for networks.

1.4 SUBMITTALS

A. In accordance with Section 409010.

1.5 QUALITY ASSURANCE

A. Test copper cable by use of time domain reflectometer (TDR) prior to installation.

B. Test fiber optic cable by use of optical time domain reflectometer (OTDR) prior to installation.

C. Record test results and provide to Owner.

PART 2 PRODUCTS

2.1 NETWORK COMPONENTS

A. General:
   1. Fiber Optic:
      a. Fiber Termination Connectors: ST.
   2. Mounting: DIN rail or rack mount components unless otherwise indicated. Type of mounting will be as shown or specified.

B. Patch Cable:
   1. Fiber:
      a. Two core fiber cable.
      b. 62.5/125 multimode.
      c. 2.9 mm outside diameter cable.

C. Patch Panel:
   1. Manufacturers:
      a. AMP.
      b. AT&T.
      c. Hubbell.
      d. Or equal.
   2. Wall mounting.
   3. Strain relief for fiber cables within box.
   4. Strain relief for wire outside box where required by cable manufacturer.
   5. Hinged cover.

2.2 ETHERNET NETWORK COMPONENTS

A. General:
   1. Copper Connectors:
      a. Wire Termination Connectors: RJ45.

B. Patch Cable:
   1. Wire:
      a. Category 5e.
      b. 4 pair.

C. Data Outlet Box (interconnection outlets):
   1. Connections appropriate for wire or fiber.
   2. Cover plate.

D. Ethernet Network Extender:
   1. Manufacturer:
      a. Patton CopperLink, Model 2151.
      b. No substitutions.

E. Surge Protection (Ethernet):
   1. Manufacturers:
      a. Phoenix Contact, Model DT-LAN-CAT.6+
      b. Or equal.
   2. RJ45 female connection RJ45 on copper cable with data rates up to 100 Mbits.
   3. Operating temperature: -40°C to 70°C.

F. Punch Down Block: Emerson Network Power, Model R6625P25, Series Part #F015360.

G. Lighting Arrestor for Punch Down Block: Bourns, Part #2420-39-N.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install LAN components in accordance with manufacturer's written instructions and ANSI/TIA/EIA-568-B specifications.

END OF SECTION

SECTION 409534
DATA COMMUNICATIONS CABLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cable for local area networks, Ethernet network, and PLC network non-Ethernet.

1.2 SYSTEM DESCRIPTION

A. Coordinate cable with drawings for networks.

1.3 SUBMITTALS

A. In accordance with Section 409010.

B. Record fiber optic cable test results and submit for approval.

1.4 QUALITY ASSURANCE

A. Test fiber optic cable by use of optical time domain reflectometer (OTDR) prior to installation.

PART 2 PRODUCTS

2.1 ETHERNET NETWORK CONNECTORS

A. Fiber Termination Connectors: ST.

B. Wire Termination Connectors: RJ45.

2.2 CABLE

A. Industrial Ethernet:
   1. Third Part Verified TIA/EIA-568-B.2, Category 5E.
   2. TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling.
   3. 4-pair conductors per network device.
   4. Ratings: CMR, CMX – Outdoor, Ethernet/IP Compliant.
   5. Installation Temperature: -25°C to +75°C; Operating Temperature: -40°C to +75°C; Passes: 25°C cold bend per UL 1581.
   6. Provide shielding as necessary when network equipment requires.
   7. Cable run between network devices shall not exceed 100 meters, including patch/jumper cables.

B. PLC Network Non-Ethernet
   1. Provide cable approved by manufacturer for network shown on drawings.
      a. For CSCAN Network Belden 3082A cable.

C. Fiber Optic Cable:
   1. General Requirements:
      a. TIA/EIA-568-B.3: Optical Fiber Cabling Components Standard.
      b. Fiber cores shall be 62.5/125 micron multimode.
      c. Minimum Bend Radius:
         1) 20X cable diameter during installation.
         2) 10X cable diameter after installation.
      d. Maximum fiber optic loss:
         1) 3.4 dB/km at 850 nm.
         2) 1.0 dB/km at 1300 nm.
      e. Minimum bandwidth:

1) 200 MHz at 850 nm.
2) 500 MHz at 1300 nm.

f. Number of core: Minimum of 6 core per cable. See Network Diagram drawing for required number.
g. Product warranty: 10 years.
h. Individual fiber cores shall have unique color code.

2. Outdoor in conduit:
   a. Stranded loose tube construction with dielectric center strength member.
   b. Cable shall contain water-blocking materials such as water swellable yarn and tapes.

D. Ethernet Extension Cable (Telephone):
   1. Manufacturer: Superior Essex Model GOPIC-F RDUP PE-39.
   2. General Requirements:
      a. Conductor size 19 awg.
      b. 6-pair individually insulated conductors; twisted into pairs with varying lay lengths; specific color combinations to provide pair identification.
      c. Shield copper bearing armor applied longitudinally with overlap; flooded shield interfaces.

E. Quad Conductor Shielded Cable (Pulsar)
   1. Manufacturer: Belden 27326AS or equal.
   2. (4) conductors 18AWG with overall shield.

PART 3 EXECUTION

3.1 INSTALLATION

A. Ethernet and PLC network non-Ethernet Cable:
   1. Install per manufacturer's guidelines.

B. Fiber Optic Cable Installation:
   1. Do not exceed cable manufacturer's minimum bend radius under tension or final installation.
   2. Cable tension:
      a. Do not exceed cable manufacturer's maximum tensile rating during cable installation.
      b. No residual tension shall remain on cable after installation, except that which is due to cable's weight in vertical rise.
      c. Cable tension shall be monitored during installation if winch is used for installation. Hand pulls do not require monitoring.
   3. Vertical Rises:
      a. Secure vertical cable at top of run using manufacturer's approved method.
      b. Attachment point shall comply with cable's minimum bend radius.
      c. Provide intermediate support when manufacturer-specified maximum cable rise has been reached.
   4. Cable Splicing and Termination:
      a. Maximum allowable attenuation figures 3.0 dB/Km @ 850 nm and 1.0 dB/Km @ 1,300 nm.
      b. Splicing:
         1) Splicing not acceptable unless specifically approved by Engineer.
         2) Splices shall not cause attenuation of signal exceeding allowable attenuation budget. Do not exceed 0.3 dB attenuation per splice.
         3) Make no splices within conduit or ductbanks. Make splices within pullboxes or process control system equipment enclosures.
      c. Terminate and seal unused fibers within cable. Cut fiber ends prior to insertion in connector.

C. Cable Marking:
   1. Fiber optic outer cable sheath shall be marked with heat shrinkable vinyl sleeves with permanent embossed letters with source and destination.
   2. Each copper Ethernet and PLC Network Non-Ethernet cable shall be marked with heat shrinkable vinyl sleeves with permanent embossed letters with source and destination.

D. Install LAN components in accordance with manufacturer's written instructions and ANSI/TIA/EIA-568-B requirements.

3.2 LAN TESTING

A. Test copper cable end-to-end by time domain reflectometer after installation.

B. Test Fiber optic cable end-to-end by optical time domain reflectometer respectively after installation.

C. Record test results and provide to Owner.

END OF SECTION