

HIGHWAY WORK PROPOSAL

Wisconsin Department of Transportation
DT1502 4/2004 s.66.29(7) Wis. Stats.

Proposal Number:

Ø 1

<u>COUNTY</u>	<u>STATE PROJECT ID</u>	<u>FEDERAL PROJECT ID</u>	<u>PROJECT DESCRIPTION</u>	<u>HIGHWAY</u>
Dane	1002-02-72	IM 2006 336	Madison – Janesville Road (Madison Safety & Weight Facility)	IH 39/90

This proposal, submitted by the undersigned bidder to the Wisconsin Department of Transportation, is in accordance with the advertised request for proposals. The bidder is to furnish and deliver all materials, and to perform all work for the improvement of the designated project in the time specified, in accordance with the appended Proposal Requirements and Conditions.

Proposal Guaranty Required, \$ 75,000.00 Payable to: Wisconsin Department of Transportation	Attach Proposal Guaranty on back of this PAGE.
Bid Submittal Due Date: June 13, 2006 Time (Local Time): 9:00 AM	Firm Name, Address, City, State, Zip Code
Contract Completion Time May 15, 2007	SAMPLE NOT FOR BIDDING PURPOSES
Assigned Disadvantaged Business Enterprise Goal 4 %	This contract is: subject to federal oversight.

This certifies that the undersigned bidder, duly sworn, is an authorized representative of the firm named above; that the bidder has examined and carefully prepared the bid from the plans, Highway Work Proposal, and all addenda, and has checked the same in detail before submitting this proposal or bid; and that the bidder or agents, officer, or employees have not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with this proposal bid.

Do not sign, notarize, or submit this Highway Work Proposal when submitting an electronic bid on the Internet.

Subscribed and sworn to before me this date _____

(Signature, Notary Public, State of Wisconsin)

(Print or Type Name, Notary Public, State Wisconsin)

(Date Commission Expires)

Notary Seal

(Bidder Signature)

(Print or Type Bidder Name)

(Bidder Title)

For Department Use Only

Type of Work Concrete pavement removal, building demolition, SWEF building, weigh-in-motion systems, static scale, concrete pavement, asphaltic pavement, site lighting and landscape planting.	Date Guaranty Returned
Notice of Award Dated	

**PLEASE ATTACH
PROPOSAL GUARANTY HERE**

Effective with August 2005 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.

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.

BID PREPARATION

Preparing the Proposal Schedule of Items

A General

- (1) Obtain bidding proposals as specified in **section 102** of the standard specifications. Submit bidding proposals using one of the following methods:
 1. Electronic bid on the internet.
 2. Electronic bid on a printout with accompanying diskette.
 3. Paper bid under a waiver of the electronic submittal requirements.
- (2) Bids submitted on a printout with accompanying diskette or paper bids submitted under a waiver of the electronic submittal requirements govern over bids submitted on the internet.
- (3) The department will provide bidding information through the department's web site at <http://www.dot.wisconsin.gov/business/engrserv/bid-letting-information.htm>. The contractor is responsible for reviewing this web site for general notices as well as information regarding proposals in each letting. The department will also post special notices of all addenda to each proposal through this web site no later than 4:00 P.M. local time on the Thursday before the letting. Check the department's web site after 5:00 P.M. local time on the Thursday before the letting to ensure all addenda have been accounted for before preparing the bid. When bidding using methods 1 and 2 above, check the Bid Express™ on-line bidding exchange at <http://www.bidx.com/> after 5:00 P.M. local time on the Thursday before the letting to ensure that the latest schedule of items Expedite file (*.ebs or *.00x) is used to submit the final bid.
- (4) Interested parties can subscribe to the Bid Express™ on-line bidding exchange by following the instructions provided at the www.bidx.com web site or by contacting:

Info Tech Inc.
5700 SW 34th Street, Suite 1235
Gainesville, FL 32608-5371
email: <mailto:customer.support@bidx.com>

- (5) The department will address equipment and process failures, if the bidder can demonstrate that those failures were beyond their control.
- (6) Contractors are responsible for checking on the issuance of addenda and for obtaining the addenda. Notice of issuance of addenda is posted on the department's web site at <http://www.dot.wisconsin.gov/business/engrserv/bid-letting-information.htm> or by calling the department at (608) 266-1631. Addenda can ONLY be obtained from the departments web site listed above or by picking up the addenda at the Bureau of Highway Construction, Room 601, 4802 Sheboygan Avenue, Madison, WI, during regular business hours.

B Submitting Electronic Bids

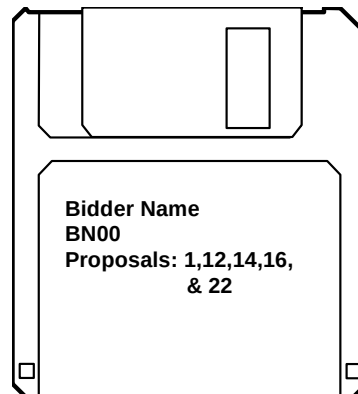
B.1 On the Internet

- (1) Do the following before submitting the bid:
 1. Have a properly executed annual bid bond on file with the department.
 2. Have a digital ID on file with and enabled by Info Tech Inc. Using this digital ID will constitute the bidder's signature for proper execution of the bidding proposal.
- (2) In lieu of preparing, delivering, and submitting the proposal as specified in **102.6** and **102.9** of the standard specifications, submit the proposal on the internet as follows:
 1. Download the latest schedule of items reflecting all addenda from the Bid Express™ web site.
 2. Use Expedite™ software to enter a unit price for every item in the schedule of items.

3. Submit the bid according to the requirements of Expedite™ software and the Bid Express™ web site. Do not submit a bid on a printout with accompanying diskette or a paper bid. If the bidder does submit a bid on a printout with accompanying diskette or a paper bid in addition to the internet submittal, the department will disregard the internet bid.
 4. Submit the bid before the hour and date the Notice to Contractors designates.
 5. Do not sign, notarize, and return the bidding proposal described in 102.2 of the standard specifications.
- (3) The department will not consider the bid accepted until the hour and date the Notice to Contractors designates.

B.2 On a Printout with Accompanying Diskette

- (1) Download the latest schedule of items from the Wisconsin pages of the Bid Express™ web site reflecting the latest addenda posted on the department's web site at <http://www.dot.wisconsin.gov/business/engrserv/bid-letting-information.htm>. Use Expedite™ software to prepare and print the schedule of items. Provide a valid amount for all price fields. Follow instructions and review the help screens provided on the Bid Express™ web site to assure that the schedule of items is prepared properly.
- (2) Staple an 8 1/2 by 11 inch printout of the Expedite™ generated schedule of items to the other proposal documents submitted to the department as a part of the bidder's sealed bid. As a separate submittal not in the sealed bid envelop but due at the same time and place as the sealed bid, also provide the Expedite™ generated schedule of items on a 3 1/2 inch computer diskette. Label each diskette with the bidder's name, the 4 character department-assigned bidder identification code from the top of the bidding proposal, and a list of the proposal numbers included on that diskette as indicated in the following example:



- (3) If bidding on more than one proposal in the letting, the bidder may include all proposals for that letting on one diskette. Include only submitted proposals with no incomplete or other files on the diskette.
- (4) The bidder-submitted printout of the Expedite™ generated schedule of items is the governing contract document and must conform to the requirements of section 102 of the standard specifications. If a printout needs to be altered, cross out the printed information with ink or typewriter and enter the new information and initial it in ink. If there is a discrepancy between the printout and the diskette, the department will analyze the bid using the printout information.
- (5) In addition to the reasons specified in section 102 of the standard specifications, proposals are irregular and the department may reject them for one or more of the following:
 1. The check code printed on the bottom of the printout of the Expedite™ generated schedule of items is not the same on each page.

2. The check code printed on the printout of the Expedite™ generated schedule of items is not the same as the check code for that proposal provided on the diskette.
3. The diskette is not submitted at the time and place the department designates.

C Waiver of Electronic Submittal

- (1) The bidder may request a waiver of the electronic submittal requirements. Submit a written request for a waiver in lieu of bids submitted on the internet or on a printout with accompanying diskette. The department will waive the electronic submittal requirements for a bidding entity (individual, partnership, joint venture, corporation, or limited liability company) for up to 4 individual proposals in a calendar year. The department may allow additional waivers for equipment malfunctions.
- (2) Submit a schedule of items on paper conforming to [section 102](#) of the standard specifications. The department charges the bidder a \$75 administrative fee per proposal, payable at the time and place the department designates for receiving bids, to cover the costs of data entry. The department will accept a check or money order payable to: "Wisconsin, Dept. of Transportation."
- (3) In addition to the reasons specified in [section 102](#) of the standard specifications, proposals are irregular and the department may reject them for one or more of the following:
 1. The bidder fails to provide the written request for waiver of the electronic submittal requirements.
 2. The bidder fails to pay the \$75 administrative fee before the time the department designates for the opening of bids.
 3. The bidder exceeds 4 waivers of electronic submittal requirements within a calendar year.
- (4) In addition to the reasons specified in [section 102](#) of the standard specifications, the department may refuse to issue bidding proposals for future contracts to a bidding entity that owes the department administrative fees for a waiver of electronic submittal requirements.

PROPOSAL BID BOND

DT1303 3/2004

Wisconsin Department of Transportation

Proposal Number	Project Number	Letting Date
Name of Principal		
Name of Surety	State in Which Surety is Organized	

We, the above-named Principal and the above-named Surety, are held and firmly bound unto the State of Wisconsin in the sum equal to the Proposal Guaranty for the total bid submitted for the payment to be made; we jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns. The condition of this obligation is that the Principal has submitted a bid proposal to the State of Wisconsin acting through the Department of Transportation for the improvement designated by the Proposal Number and Letting Date indicated above.

If the Principal is awarded the contract and, within the time and manner required by law after the prescribed forms are presented for signature, enters into a written contract in accordance with the bid, and files the bond with the Department of Transportation to guarantee faithful performance and payment for labor and materials, as required by law, or if the Department of Transportation shall reject all bids for the work described, then this obligation shall be null and void; otherwise, it shall be and remain in full force and effect. In the event of failure of the Principal to enter into the contract or give the specified bond, the Principal shall pay to the Department of Transportation **within 10 business days of demand** a total equal to the Proposal Guaranty as liquidated damages; the liability of the Surety continues for the full amount of the obligation as stated until the obligation is paid in full.

The Surety, for value received, agrees that the obligations of it and its bond shall not be impaired or affected by any extension of time within which the Department of Transportation may accept the bid; and the Surety does waive notice of any such extension.

IN WITNESS, the Principal and Surety have agreed and have signed by their proper officers and have caused their corporate seals to be affixed this date:

PRINCIPAL

(Company Name) (Affix Corporate Seal)

(Signature and Title)

(Company Name)

(Signature and Title)

(Company Name)

(Signature and Title)

(Company Name)

(Signature and Title)

NOTARY FOR PRINCIPAL

(Date)

State of Wisconsin)
) ss.
_____ County)

On the above date, this instrument was acknowledged before me by the named person(s).

(Signature, Notary Public, State of Wisconsin)

(Print or Type Name, Notary Public, State of Wisconsin)

(Date Commission Expires)

Notary Seal

(Name of Surety) (Affix Seal)

(Signature of Attorney-in-Fact)

NOTARY FOR SURETY

(Date)

State of Wisconsin)
) ss.
_____ County)

On the above date, this instrument was acknowledged before me by the named person(s).

(Signature, Notary Public, State of Wisconsin)

(Print or Type Name, Notary Public, State of Wisconsin)

(Date Commission Expires)

Notary Seal

IMPORTANT: A certified copy of Power of Attorney of the signatory agent must be attached to the bid bond.

CERTIFICATE OF ANNUAL BID BOND

DT1305 8/2003

Wisconsin Department of Transportation

Time Period Valid (From/To)	
Name of Surety	
Name of Contractor	
Certificate Holder	Wisconsin Department of Transportation

This is to certify that an annual bid bond issued by the above-named Surety is currently on file with the Wisconsin Department of Transportation.

This certificate is issued as a matter of information and conveys no rights upon the certificate holder and does not amend, extend or alter the coverage of the annual bid bond.

Cancellation: Should the above policy be cancelled before the expiration date, the issuing surety will give thirty (30) days written notice to the certificate holder indicated above.

(Signature of Authorized Contractor Representative)

(Date)

FEBRUARY 1999

LIST OF SUBCONTRACTORS

Section 66.29(7), Wisconsin Statutes, provides that a bidder, as a part of his proposal, shall submit a list of the subcontractors he proposes to contract with and the class of work to be performed by each, provided that to qualify for such listing each subcontractor must first submit his bid in writing to the general contractor at least 48 hours prior to the time of bid closing. It further provides that a proposal of a bidder shall not be invalid if any subcontractor, and the class of work to be performed by such subcontractor, has been omitted from a proposal.

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
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

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.

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SPECIAL PROVISIONS

1. General.

Perform the work under this construction contract for Project 1002-02-72, Madison – Janesville Road, (Madison Safety & Weight Facility), IH 39/90, Dane County, Wisconsin as the plans show and execute the work as specified in the State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, 2003 Edition, the Supplemental Specifications 2005 Edition, and these special provisions including the Additional Special Provisions (ASP's). The department considers only standard specifications, supplemental specifications and interim supplemental specifications issued directly from the department as valid for this contract.

If all or a portion of the plans and special provisions are developed in the SI metric system and the schedule of prices is developed in the US standard measure system, the department will pay for the work as bid in the US standard system.
(090105)

2. Scope of Work.

The work under this contract shall consist of concrete pavement removal, building demolition, SWEF building, weigh-in-motion systems, static scale, concrete pavement, asphaltic pavement, site lighting, landscape planting and all incidental items necessary to complete the work as shown on the plans and included in the proposal and contract.
(082003) 104-005

3. Prosecution and Progress.

Begin work within 10 calendar days after the engineer issues a written notice to proceed.

Provide the start date to the engineer in writing within a month after executing the contract but at least 14 calendar days before the preconstruction conference. Upon approval, the engineer will issue the notice to proceed within 10 calendar days before the approved start date.

To revise the start date, submit a written request to the engineer at least two weeks before the intended start date. The engineer will approve or deny that request based on the conditions cited in the request and its effect on the department's scheduled resources.
(082003) 108-010

Supplement 108.11 as follows:

The Substantial Completion date for the weigh facility shall be **Friday, March 30, 2007**. The Substantial Completion date is defined as the date in which the progress of the work is sufficiently complete for the owner and/or owner's representative and/or the project

engineer occupy and use the facility, receive equipment training and develop the final punch list. The Substantial Completion date is also the date of commencement of applicable warranties required by the contract documents. If the facility is not substantially complete at that time, a deduction of \$500 per calendar day or portion thereof, will be made from money due under this contract for Project ID 1002-02-72 for each calendar day the contract work remains incomplete.

The department will not grant time extensions to the interim completion dates specified above for the following:

1. Severe weather as specified in 108.10.2.2.
2. Labor disputes that are not industry wide.
3. Delays in material deliveries.

If contract time expires before completing all work specified in the contract, additional liquidated damages will be affixed in accordance with 108.11 of the standard specifications.

Each day shall be defined as a twenty-four (24) hour period beginning at 12:01 AM.

4. Prosecution and Progress – Subletting The Contract.

The first sentence of the third paragraph in subsection 108.1 of the standard specifications is deleted and replaced with the following:

The contractor shall perform at least 20 percent of the original contract amount with the contractor's own organization.

5. Traffic.

IH 39/90, on which this project is located, shall remain open to through traffic with two lanes open at all times, except for the mainline weigh-in-motion installation.

For mainline weigh-in-motion installation, IH 39/90 southbound may be reduced to one-lane traffic during the hours of 8:00 PM to 5:00 AM, Monday through Thursday, during the following time periods:

1. September 5, 2006 through November 2, 2006 except October 9, 2006.
2. April 2, 2007 through May 3, 2007.

Installation work on the Virtual Weigh-In-Motion sites shall not occur between 6:00 AM and 8:00 AM.

Notify all emergency government units of the location and duration of any temporary lane or roadway closures at least 24 hours prior to such closures. For mainline and each virtual weigh-in-motion installation, erect portable message boards at least seven days prior to the start of installation. The message shall inform motorists of the starting date of installation.

Perform the work under this contract in a manner that will not interfere with the travel lanes

and shoulders on IH 39/90 except as indicated on the plans. Vehicles, equipment and materials may be stored at locations within the roadway right of way. Maintain a clear width of at least 30 feet from the edge of the traveled lanes on IH 39/90 except during the performance of required work within this clear zone.

During the weigh-in-motion installation, place drums and traffic control devices in the traffic lane such that there is a single 12-foot minimum clear lane width. This reduced lane width shall be allowed only for the time necessary to complete saw cutting and weigh-in-motion component installation. Immediately upon completion of each operation, place the drums and traffic control devices such that the live traffic lanes are entirely clear.

Do not park vehicles not engaged in the construction operations within the right-of-way for the IH 39/90 roadway. Equip all vehicles and equipment entering or leaving the live traffic lanes on IH 39/90 with a hazard identification beacon (flashing yellow signal) of 8-inch diameter. The beacon shall be activated when merging or exiting a live traffic lane. All vehicles and equipment entering or exiting live traffic lanes shall yield to through traffic. Authorized vehicles will be allowed to park along the right shoulder of IH 39/90 only when there is no other access to the work area and only when there is a lane closure in effect.

6. Holiday Work Restrictions

Do not perform work of any kind on or along any of the project sites during the following holiday periods:

From noon Friday, September 1, 2006 to 6:00 AM Tuesday September 5, 2006;

From noon Wednesday, November 22, 2006 to 6:00 AM Monday, November 27, 2006;

From noon Friday, December 22, 2006 to 6:00 AM Tuesday, December 26, 2006;

From noon Friday, December 29, 2006 to 6:00 AM Tuesday, January 2, 2007.

(050205)

7. Utilities.

The provisions of administrative rule TRANS 200 do not apply to this project.

Make arrangements and coordinate through the proper utility company for service. Obtain all necessary permits. Coordinate all required utility work in accordance with subsection 107.22 of the standard specifications, and pay for the shut-off of existing site utilities and installation of new site utilities and tie-ins as may be necessary to complete the work.

Verizon provides telephone service and has a telephone service line to the site. The new SWEF building will require telephone service.

Alliant Energy provides electric service to the site. The new SWEF building and site lighting will require electrical service.

Contact each utility company listed in the plans, prior to preparing bids, to obtain current information on the status of existing and any new utility relocation work.

New Telephones. A payphone vender to be chosen by the department will provide the new payphone. Others will provide all other permanent telephones. The building electrical contractor shall provide one telecommunications device for the deaf (TTY). The specification for this device can be found under the item of SWEF Building, Electrical.

Conduit for crossing under new paved areas to be provided by the contractor under separate contract bid items.

8. Existing Tree Protection.

The contractor is advised of the presence of existing trees located within the project limits. These trees are either within the roadway right-of-way or are near the grading limits of the project. The tree protection locations are indicated on the plans and are as follows:

Sta. 346'R'+15, RT.	Sta. 1'S'+75, RT.	Sta. 7'S'+20, RT.
Sta. 352'R'+12, RT.	Sta. 2'S'+41, RT.	Sta. 7'S'+80, RT.
Sta. 0'S'+75, RT.	Sta. 6'S'+88, RT.	Sta. 9'S'+00, RT.

Use extreme care to ensure these trees are not disturbed by construction operations.

If the trees are damaged by the contractor, the contractor shall be responsible for all repair or replacement costs.

9. Asbestos Removal.

A Regulations

Comply with the requirements of EPA regulations, National Emission Standards for Asbestos, and OSHA regulations on asbestos removal and applicable DNR and local government regulations. In addition the following must be met:

Any person performing asbestos abatement must be trained, and certified by the Department of Health and Social Services under the provisions of Chapter HSS 159, Wis. Adm. Code. Demolition contractors involved in projects where no asbestos is to be removed do not have to be certified.

Give proper notification to the Department of Natural Resources and Department of Health and Social Services at least 10 working days prior to starting the project.

B Friable Asbestos

B.1 Description

This work shall consist of the removal of all friable asbestos material found in any of the buildings designated for razing or removal under this contract.

Friable asbestos material is defined as any material that contains more than one percent asbestos by area as measured using Polarized Light Microscopy, and can be crumbled, pulverized or reduced to powder, when dry, by hand pressure.

Carefully lower asbestos materials to the ground floor; do not drop or throw.

B.2 Scope of Work.

Asbestos has been identified in the interior floor tiles and underlying mastic. An asbestos survey report is available from Bob Spoerl, WisDOT Roadside Facilities Unit, at (608) 266-8665. The contractor shall furnish all labor, materials, services, insurance and equipment necessary to carry out the removal operations in accordance with the EPA, OSHA and applicable DNR and local government regulations.

The contractor shall be responsible for obtaining approval for a waste disposal site in compliance with DNR regulations.

Contractor shall post the EPA, OSHA and applicable DNR and local government regulations at the job site.

B.3 Worker Protection

When Exposure Limits Exceed Minimum Standards: Provide workers with approved respirators. Provide a sufficient quantity of filters approved for asbestos so that workers can change filters during the workday. Filters shall not be used for any longer than one (1) working day. Store the respirator filters at the job site in the change room and totally protect them from exposure to asbestos prior to their use.

Workers shall always wear a respirator properly fitted on the face in the work area.

Instruct and train workers in proper respirator use.

Workers shall wear disposable, full-body coveralls and disposable head covers and footwear in the work area. Non-disposable footwear shall be left in the work area at all times until disposal at job completion.

Set up a change room and a shower outside of the work area.

All workers, without exception, shall remove street clothes in the change room and put on the disposable coveralls and head covers, and respirator before entering the work area.

Workers shall remove the disposable coveralls, head covers, and footwear in the work area. Still wearing their respirators, workers shall proceed to the showers and remove their respirators while showering with soap and water.

Workers shall shower at the end of each day's work before entering the change room to change into street clothes.

Workers shall not eat, drink, smoke, chew gum or chew tobacco in the work area. To eat, drink or smoke, workers shall remove the disposable work clothes and footwear in the work area. Still wearing their respirators, workers shall proceed to the showers and remove their respirators while showering with soap and water. Workers shall then dress

into a new, clean disposable coverall to eat, smoke or drink. The new coverall can be worn to re-enter the work area.

The contractor shall provide a respirator and disposable coveralls, head cover, and footwear to the engineer or any official representative who inspects the job site.

All persons entering the work area shall wear an approved respirator and disposable coveralls, head cover, and footwear.

B.4 Work Area Preparation

When Exposure Limits Exceed Minimum Standards: Set up a decontamination facility outside of the work area which will consist of a change room, shower area, and equipment area.

Isolate the work area for the duration of the work by completely sealing off all openings and fixtures in the work area including, but not limited to, heating and ventilation ducts, doorways, corridors, windows, skylights, and light with plastic sheeting taped securely in place.

Build double barriers of plastic sheeting at all entrances and exits to the work area so that the work area is always closed off by one barrier when workers enter or exit.

Cover all floor and wall surfaces in the work area with plastic sheeting taped securely in place to protect from water damage (or damage by sealants).

Before the work is begun, wet clean all removable items and equipment not located on the asbestos material, remove them from the work area, and then return these items and equipment to the work area after the job has been completed and the area has been decontaminated.

Cover all non-removable items and equipment in the work area with plastic sheeting taped securely in place.

After work area isolation, take out all detachable electrical, heating, ventilation equipment, and other items located on the asbestos material, clean them before covering them with plastic sheeting taped securely in place, and return them to their proper place after the job has been completed and the work area has been decontaminated.

Remove all heating, ventilation, and air conditioning system filters, pack them in sealable plastic bag (6-mil minimum) for burial in the approved waste disposal site and replace them with new filters.

Establish emergency and fire exits from the work area. Emergency procedures shall have priority.

B.5 Method of Removal

Spray the asbestos material with water containing a wetting agent to enhance penetration. The wetting agent shall be 50% polyoxyethylene ester and 50% polyoxyethylene ether (Aqua-GRO*), or the equivalent, in a concentration of one (1) ounce in five (5) gallons of water. Apply a fine spray of the amended water to reduce fiber release preceding the removal of the asbestos material. Sufficiently saturate the material to prevent emission of airborne fibers in excess of the exposure limits prescribed in the OSHA regulations referenced in these specifications. Also apply a fine spray of the amended water to reduce fiber release during the removal of the asbestos material. There cannot be any visible emissions from the removal process.

Remove the asbestos material in small sections by two-person teams on staging platforms. Before beginning the next section, pack the adequately wetted material and seal into leak tight plastic containers and place into fiber or metal drums or skips for transport. Mark bags, drums and skips with the OSHA label prescribed by the OSHA regulations referenced in these specifications. Clean the outside of all containers before leaving the work area.

Pack all plastic sheeting, tape, cleaning material, clothing, and all other disposable material or items used in the work area into sealable plastic bags (6-mil minimum) and place into metal or fiber drums or skips for transport. Mark the drums and skips with the OSHA label prescribed by the OSHA regulations referenced in these specifications.

Transport the sealed drums or skips to the approved waste disposal site. The sealed plastic bags may be dumped from the drums into the burial site unless the bags have been broken or damaged. Leave the damaged bags in the drum and bury the entire contaminated drum. Uncontaminated drums may be recycled. A copy of the manifest of each load of contaminated material from the waste disposal site shall be required to be furnished to the department before payment for each contaminated parcel is made. The waste hauler must be licensed by the Department of Natural Resources.

B.6 Decontamination of Work Area

Clean all surfaces in the work area with water and/or with a high efficiency particulate absolute filtered vacuum. After cleaning the work area, wait 24 hours to allow for settlement of dust, and then wet-clean all surfaces in the work area again. After completion of the second cleaning operation, perform a complete visual inspection of the work area to ensure that the work area is dust free. Take two air samples within 48 hours after completion of all cleaning work, as prescribed by regulations.

If the official representative finds that the work area has not been decontaminated, repeat the cleaning and air monitoring until the work area is in compliance.

After the work area is found to be in compliance, unseal all entrances and exits and the dispose of plastic sheeting, tape, and any other trash and debris in sealable plastic bags (6-mil minimum) and bury in the approved waste disposal site.

B.7 Air Monitoring

Air monitoring shall be conducted according to the method prescribed by the OSHA regulations.

Perform air monitoring by taking samples during the period of asbestos removal. Samples should only be taken after actual work has proceeded.

C Non-Friable Asbestos

C.1 Description

This work shall consist of the removal of all non-friable asbestos material found in any of the buildings designated for razing and removing.

Non-friable asbestos is divided into two categories. Category I is defined as any resilient floor covering or asphalt roofing product. Category II is defined as any non-friable material, excluding Category I non-friable.

Category I Non-Friable Asbestos (1) Description. This material does not have to be removed prior to demolition of a structure provided it is in good condition and not friable at the time of demolition. The resulting waste materials can be handled as regular demolition material.

Category II Non-Friable Asbestos. (1) Description. This work shall consist of the removal of all Category II non-friable asbestos material found in any buildings designated for razing and removing.

Asbestos-cement products are dense non-friable forms of asbestos. However, normal breakage and crushing resulting from the demolition of structures can release asbestos fibers from these materials. If this release occurs, then the activity becomes subject to the EPA National Emissions Standards for Hazardous Air Pollutants, OSHA worker safety standards, DNR and local regulations.

C.2 Removal

Prior to demolition of the structure, remove all asbestos-cement siding material. If the removal can be handled in such a way as to ensure that the asbestos material remains non-friable, then the EPA and OSHA regulations do not apply. Follow the removal procedures listed below to ensure that the asbestos material remains non-friable and that the release of asbestos fibers is minimized.

- a. Remove siding by hand.
- b. Limit breakage during removal to the nailed corners.
- c. Keep working areas wetted during removal.
- d. Do not drop siding to the ground so as to cause breakage.
- e. Place stripped siding in a truck, trailer or roll-off lined with visqueen.
- f. Cover truck, trailer or roll-off securely when work is not in progress and during transport to the landfill.

If these procedures cannot be followed, then employ a bona fide asbestos abatement contractor to handle the removal; all state and federal regulations apply.

C.3 Disposal

Dispose of all asbestos-cement siding material at a sanitary landfill that has been authorized by the Department of Natural Resources to accept asbestos waste. The department must also approve the landfill selection prior to disposal. Document all asbestos waste disposal and provide said documentation to the department upon completion of the removal and disposal work, and before payment for that removal is made.

D Measurement

Asbestos removal is considered incidental to razing and removing buildings and will not be measured for payment separately.

10. Removing Building, Sta. 351'R'+00.

The contractor is hereby notified that the existing weigh station building has asbestos-containing material in the interior floor tiles and underlying mastic. The asbestos content of these materials is two percent Chrysotile asbestos.

As part of the building removal, remove and dispose of all asbestos-containing materials in accordance with applicable state and federal regulations.

11. Removing Pull Boxes, Item 204.9060.S.

A Description

This special provision describes removing pull boxes in accordance with the pertinent provisions of section 204 of the standard specifications and as hereinafter provided.

B (Vacant)

C (Vacant)

D Measurement

The department will measure Removing Pull Boxes as each pull box acceptably completed, including all attached parts and connections.

E Payment

Supplement 204.5 to include the following:

ITEM NUMBER	DESCRIPTION	UNIT
204.9060.S	Removing Pull Boxes	Each
(100504) 204-025		

12. QMP Base Aggregate, Item 301.0100.S.

A Description

A.1 General

- (1) This special provision describes contractor quality control (QC) sampling and testing for base aggregates, documenting those test results, and documenting related production and placement process changes. This special provision also describes department quality verification (QV), independent assurance (IA), and dispute resolution.
- (2) Conform to sections 301, 305, and 310 of the standard specifications as modified here in this special provision. Apply this special provision to material placed under all of the Base Aggregate Dense and Base Aggregate Open Graded bid items, except do not apply this special provision to material classified as reclaimed asphaltic pavement placed under the Base Aggregate Dense bid items.
- (3) Do not apply this special provision to material placed under the Aggregate Detours, Salvaged Asphaltic Pavement Base, Breaker Run, Select Crushed, Pit Run, Subbase, or Riprap bid items.
- (4) Provide and maintain a quality control program, defined as all activities related to and documentation of the following:
 1. Production and placement control and inspection.
 2. Material sampling and testing.
- (5) Chapter 4 of the department's construction and materials manual (CMM) provides additional detailed guidance for QMP work and describes required sampling and testing procedures. The contractor may obtain the CMM from the department's extranet site at:
<https://trust.dot.state.wi.us/extntgtwy/dtidcons/constnds/cmm/cmm.htm>

A.2 Contractor Testing for Small Quantities

- (1) The department defines a small quantity, for each individual Base Aggregate bid item, as a plan quantity of 9000 tons (9000 Mg) or less of material as shown in the schedule of items under that bid item.
- (2) The requirements under this special provision apply equally to a small quantity for an individual bid item except as follows:
 1. The contractor need not submit a full quality control plan but shall provide an organizational chart to the engineer including names, telephone numbers and current certifications of all persons involved in the quality control program for material under affected bid items.
 2. Divide the aggregate into uniformly sized sublots for testing as follows:

PLAN QUANTITY	MINIMUM REQUIRED TESTING
≤ 1500 tons (1500 Mg)	One test from production, load-out, or placement at the contractor's option.
>1500 tons (1500 Mg) and ≤ 6000 tons (6000 Mg)	Two tests of the same type, either from production, load-out, or placement at the contractor's option.
>6000 tons (6000 Mg) and ≤ 9000 tons (9000 Mg)	Three placement tests ^{[1] [2]}

^[1] For 3-inch material, obtain samples at load-out.

^[2] If the actual quantity overruns 9000 tons (9000 Mg), create overrun sublots to test at a rate of one additional placement test for each 3000 tons (3000 Mg), or fraction of 3000 tons (3000 Mg), of overrun.

3. No control charts are required. Submit aggregate test results to the engineer within one business day of obtaining the sample. Assure that all properties are within the limits specified in the standard specifications for each test.
 4. Department verification testing is optional for quantities of 6000 tons (6000 Mg) or less.
- (3) Material represented by a subplot with any property outside the specification limits is nonconforming. The department may reject material or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

B Materials

B.1 Contractor Quality Control Program Requirements

B.1.1 Quality Control Plan

- (1) Submit a comprehensive written quality control plan to the engineer at or before the pre-construction meeting. Do not place base before the engineer reviews and comments on the plan. Construct the project as that plan provides.
- (2) Do not change the quality control plan without the engineer's review. Update the plan with changes as they become effective. Provide a current copy of the plan to the engineer and post in each of the contractor's laboratories as changes are adopted. Ensure that the plan provides the following elements:
 1. An organizational chart with names, telephone numbers, current certifications and/or titles, and roles and responsibilities of QC personnel.
 2. The process used to disseminate QC information and corrective action efforts

to the appropriate persons. Include a list of recipients, the communication means that will be used, and action time frames.

3. A list of source and processing locations, section and quarter descriptions, for all aggregate materials requiring QC testing.
4. Test results for wear, sodium sulfate soundness, freeze/thaw soundness, and plasticity index of all aggregates requiring QC testing. Obtain this information from the district materials unit or from the engineer.
5. Descriptions of stockpiling and hauling methods.
6. Locations of the QC laboratory, retained sample storage, and where control charts and other documentation is posted.
7. An outline for resolving a process control problem. Include responsible personnel, required documentation, and appropriate communication steps.

B.1.2 Personnel Requirements

- (1) Have personnel certified under the department's highway technician certification program (HTCP) perform sampling and testing as follows:

Required certification Level:	Sampling or Testing Roles:
Aggregate Technician I or IPP Aggregate Sampling Technician Assistant Certified Technician (ACT)	Aggregate Sampling ^[1]
Aggregate Technician I or IPP Assistant Certified Technician (ACT)	Aggregate Gradation Testing, Aggregate Fractured Particle Testing
Aggregate Technician IPP Assistant Certified Technician (ACT)	Aggregate Permeability Testing

^[1] Plant personnel under the direct observation of a aggregate technician certified at level one or higher may operate equipment to obtain samples.

- (2) Ensure that sampling and testing by an assistant certified technician conforms to all of the following:
 1. Sampling by an ACT is done under the direct observation of a aggregate technician certified at level one or higher.
 2. Testing by an ACT is done under the direct supervision of an aggregate technician certified at level one or higher
 3. No more than one ACT reports to an individual certified technician.
- (3) Have an aggregate technician certified at level one or higher perform all data analysis and posting.

B.1.3 Laboratory Requirements

- (1) Perform QC testing at a department qualified laboratory. Obtain information on the Wisconsin laboratory qualification program from:

Quality Management Section
3502 Kinsman Blvd.
Madison Wisconsin 53704
Telephone: 608-246-3246
<http://www.dot.state.wi.us/business/engrserv/lab-qualification.htm>

B.1.4 Quality Control Documentation

B.1.4.1 General

- (1) Submit base aggregate production and placement documentation to the engineer within 10 business days after completing base placement. Ensure that the submittal is complete, neatly organized, and includes applicable project records and control charts. If conducting post-production testing, also include post-production documentation.

B.1.4.2 Records

- (1) Document all production and placement observations, inspection records, and control adjustments daily in a permanent field record. Also include all test results in the project records. Provide test results to the engineer within 6 hours after obtaining a sample. For 3-inch base, extend this 6-hour limit to 24 hours. Post or distribute tabulated results using a method mutually agreeable to the engineer and contractor.

B.1.4.3 Control Charts

- (1) Plot gradation, permeability, and fracture on the appropriate control chart as soon as test results are available. Format control charts according to CMM 4-15-12. Include the project number on base placement control charts. Maintain separate control charts for each base aggregate size, source or classification, and type.
- (2) Provide control charts to the engineer within 6 hours after obtaining a sample. For 3-inch base, extend this 6-hour limit to 24 hours. Post or distribute charts using a method mutually agreeable to the engineer and contractor. Update control charts daily to include the following:
 1. Contractor individual QC tests.
 2. Department QV tests.
 3. Department IA tests.
 4. Four-point running average of the QC tests.
- (3) Except as specified under B.2.2.1 for out-of-tolerance QV tests, include only QC tests in the running average. The contractor may plot process control or informational tests on control charts, but do not include these tests, in-tolerance QV tests, or IA tests in the running average.

B.1.5 Contractor Quality Control Testing

B.1.5.1 Production Testing

- (1) Test gradation and fracture during production of each base aggregate size, source or classification, and type. Sample from either the finished product conveyor belt or stockpiles using the same procedure throughout the project. Determine random

sample locations according to CMM 4-15-12 and collect samples according to CMM 4-25-50.

- (2) Test gradation once per 1500 tons (1500 Mg) during initial production from a source, or if switching to a new base aggregate size or classification. For 3-inch base, test once per 3000 tons (3000 Mg) up to a maximum of 2 tests per day during initial production. Test at the initial frequency until 3 consecutive running average points for all the gradation sieves are within the warning limits. Subsequently, the contractor may reduce the frequency to one test per day if all gradation running averages remain within the warning limits. If any gradation running average is outside the warning limits, resume testing at the initial frequency.
- (3) Test fracture for each gradation test until the fracture running average is above the lower warning limit. Subsequently, the contractor may reduce the frequency to one test per 10 gradation tests if the fracture running average remains above the warning limit.
- (4) Provide production test records for aggregate produced before the contract. The engineer will review this documentation to determine if testing conforms to the contract. The engineer may reject material if testing is nonconforming. The engineer may subsequently approve this material for placement if the contractor provides additional post-production test results, as specified in B.1.5.2, to supplement otherwise nonconforming testing.

B.1.5.2 Post-Production Testing

B.1.5.2.1 Stockpile 3-Test Averages

- (1) Collect 3 random samples from each stockpile not adequately tested during production. Test each sample for fracture and gradation. Calculate a 3-test average for fracture and for the percent passing each sieve. The engineer will determine additional requirements as follows:
 1. If the fracture 3-test average or any gradation 3-test average exceeds its respective warning limits, the engineer will reject the stockpile unless the contractor elects to rework it. If electing to rework the stockpile, test the material during reworking as required for production testing under B.1.5.1. Plot the reworking test results on a separate control chart. Include the 3-test averages and their component individual tests on that control chart, but do not include them in the running average. No load-out testing is required.
 2. If the fracture 3-test average and all the gradation 3-test averages fall within their respective warning limits, the engineer will approve the stockpile subject to load-out testing. Conduct and document additional testing during load-out as specified in B.1.5.2.2. Include the 3-test averages and their component individual tests on the load-out control chart, but do not include them in the running average.

B.1.5.2.2 Load-Out Testing

- (1) For stockpiles approved without reworking under B.1.5.2.1, test gradation and fracture during load-out as follows:

DAILY LOAD-OUT in tons or Mg	TESTS PER DAY
≥500 to <1500	1
≥1500	2

- (2) Plot the load-out test results on a separate control chart.
- (3) Test fracture for each gradation test until the fracture running average is above the lower warning limit. Subsequently, the contractor may reduce the frequency to one test per 10 gradation tests if the fracture running average remains above the warning limit.
- (4) Stop placing material if any load-out running average exceeds its warning limits. Collect 3 random samples from the remaining stockpile. The engineer will evaluate the remaining stockpile as specified in B.1.5.2.1. Proceed with post-production testing of the remaining stockpile as specified in B.1.5.2.1.

B.1.5.3 Placement Testing

- (1) Test gradation and fracture during placement for each base aggregate size, source or classification, and type. The contractor may test permeability of open graded base instead of gradation, but must then use permeability testing throughout the project. The engineer will not require fracture testing if all production running averages are above the warning limit. The engineer may reinstate fracture testing if verification tests fall below the warning limit.
- (2) Determine random sample locations according to CMM 4-15-12 and collect samples from the grade according to CMM 4-25-50. Each day before placement, have an aggregate technician determine random sample locations based on the contractor's estimate for that day's placement quantity and provide those sample locations to the engineer. Obtain samples after the material has been bladed, mixed, and shaped but before compacting; except collect 3-inch samples from the stockpile at load-out. Do not sample from material used to maintain local traffic or from areas of temporary base that will not have an overlying pavement. On days when placing only material used to maintain local traffic or only temporary base that will not have an overlying pavement, no placement testing is required.
- (3) Split each contractor QC sample and identify it according to CMM 4-15-12. Retain the split for 7 calendar days in a dry, protected location. If requested for department comparison testing, deliver the split to the engineer within one business day.
- (4) Test gradation or permeability once per 3000 tons (3000 Mg) of estimated placement up to a maximum of 3 tests per day, or one sample per 5 days of placement whichever

is most frequent. Include unsampled material in the estimate for the next day's placement as follows:

1. If actual placement falls short of a planned random test location.
 2. If actual placement over runs and less than 3 tests are made that day.
- (5) The engineer may require additional sampling and testing to evaluate suspect material or the technician's sampling and testing procedures.
- (6) If required, test fracture for each gradation or permeability test until the fracture running average is above the lower warning limit. Subsequently, the contractor may reduce the frequency to one test per 10 gradation or permeability tests if the fracture running average remains above the warning limit.

B.1.6 Test Methods

B.1.6.1 Gradation

- (1) Test gradation using a washed analysis conforming to the following as modified in CMM 4-25-50:
- | | |
|---|-------------|
| Gradation | AASHTO T 27 |
| Material finer than the No. 200 (75 µm) sieve | AASHTO T 11 |
- (2) For 3-inch base, if 3 consecutive running average points for the percent passing the No. 200 (75µm) sieve are 8.5 percent or less, the contractor may use an unwashed analysis. Wash at least one sample out of 10. If a single running average for the percent passing the No. 200 (75µm) sieve exceeds 8.5 percent, resume washed analyses until 3 consecutive running average points are again 8.5 percent passing or less.
- (3) Maintain a separate control chart for each sieve size specified in section 305 or 310 of the standard specifications for each base aggregate size, source or classification, and type. Set control and warning limits based on the standard specification gradation limits as follows:
1. Control limits are at the upper and lower specification limits.
 2. There are no upper warning limits for sieves allowing 100 percent passing and no lower control limits for sieves allowing 0 percent passing.
 3. Dense graded warning limits, except for the No. 200 (75µm) sieve, are 2 percent within the upper and lower control limits. Warning limits for the No. 200 (75µm) sieve are set 0.5 percent within the upper and lower control limits.
 4. Open graded warning limits for the one-inch (25.0 mm), 3/8-inch (9.5 mm), and No. 4 (4.75 mm) sieves are 2 percent within the upper and lower control limits. Upper warning limits for the No. 10 (2.00 mm), No. 40 (425µm), and No. 200 (75µm) sieves are one percent inside the upper control limit.

B.1.6.2 Fracture

- (1) Test fracture conforming to CMM 4-25-50. The engineer will waive fractured particle testing on quarried stone.

- (2) Maintain a separate fracture control chart for each base aggregate size, source or classification, and type. Set the lower control limit at the contract specification limit, either specified in another special provision or in table 301-2 of 301.2.3.5 of the standard specifications. Set the lower warning limit 2 percent above the lower control limit. There are no upper limits.

B.1.6.3 Permeability

- (1) Test permeability using equipment and procedures conforming to the department's falling head permeameter test as described in CMM 4-15-32.
- (2) The individual test specification limit is a minimum of 700 feet/day (200 m/day). An individual test is the average of three permeability test values from a single sample (K_n).
- (3) Maintain a separate permeability control chart for each open graded base source. Set the running average lower control limit at 1000 feet/day (300 m/day). Set the running average lower warning limit at 1300 feet/day (400 m/day). There are no upper limits.

B.1.7 Corrective Action

B.1.7.1 General

- (1) Consider corrective action when the running average trends toward a warning limit. Take corrective action if an individual test exceeds the contract specification limit. Document all corrective actions both in the project records and on the appropriate control chart.

B.1.7.2 Production Corrective Action

- (1) Take corrective action if the running average exceeds a warning limit. Part of this required corrective action is a return to the initial testing frequencies specified in B.1.5.1. The contractor may subsequently reduce the frequency if conditions specified for reduced frequency testing under B.1.5.1 are met.

B.1.7.3 Placement Corrective Action

- (1) Do not blend additional material on the roadbed to correct gradation or permeability problems.
- (2) Notify the engineer whenever the running average exceeds a warning limit. When 2 consecutive running averages exceed a warning limit, the engineer and contractor will discuss appropriate corrective action. Perform the engineer's recommended corrective action and increase the testing frequency as follows:
 1. For gradation or permeability, increase the QC testing frequency to at least one randomly sampled test per 1000 tons (1000 Mg) placed.
 2. For fracture, increase the QC testing frequency to at least one test per gradation or permeability test.
- (3) If corrective action improves the property in question such that the running average after 4 additional tests is within the warning limits, the contractor may return to the

testing frequency specified in B.1.5.3. If corrective action does not improve the property in question such that the running average after 4 additional individual tests is still in the warning band, repeat the steps outlined above starting with engineer notification.

- (4) If the running average exceeds a control limit, material starting from the first running average exceeding the control limit and ending at the first subsequent running average inside the control limit is nonconforming and subject to pay reduction.
- (5) For individual test results significantly outside the control limits, notify the engineer, stop placing base, and suspend other activities that may affect the area in question. The engineer and contractor will jointly review data, data reduction, and data analysis; evaluate sampling and testing procedures; and perform additional testing as required to determine the extent of potentially unacceptable material. The engineer may direct the contractor to remove and replace that material. Individual test results are significantly outside the control limits if meeting one or more of the following criteria:
 1. A gradation control limit for any sieve is exceeded by more than 5 percent.
 2. Permeability is less than 700 feet/day (200 m/day).
 3. The fracture control limit is exceeded by more than 10 percent.

B.2 Department Testing

B.2.1 General

- (1) The department will conduct verification testing to validate the quality of the product and independent assurance testing to evaluate the sampling and testing. The department will provide the contractor with a listing of names and telephone numbers of all QV and IA personnel for the project, and provide test results to the contractor within 2 business days after the department obtains the sample.

B.2.2 Verification Testing

B.2.2.1 General

- (1) The department will have an HTCP technician, or ACT under the direction of a certified technician, perform QV sampling and testing. Department verification testing personnel must meet the same certification level requirements specified in B.1.2 for contractor testing personnel for each test result being verified. The department will notify the contractor before sampling so the contractor can observe QV sampling.
- (2) The department will conduct QV tests of each base aggregate size, source or classification, and type during placement conforming to the following:
 1. One non-random test on the first day of placement.
 2. At least one random test per 30,000 tons (30 000 Mg), or fraction of 30,000 tons (30 000 Mg), placed.
- (3) The department will sample randomly, at locations independent of the contractor's QC work, collecting one sample at each QV location. The department will collect QV

samples after the material has been bladed, mixed, and shaped but before compacting; except, for 3-inch aggregates, the department will collect samples from the stockpile at load-out. The department will split each sample, test half for QV, and retain half.

- (4) The department will conduct QV tests in a separate laboratory and with separate equipment from the contractor's QC tests. The department will use the same methods specified for QC testing. If the contractor chooses permeability for QC testing, the department will use permeability for QV testing.
- (5) The department will assess QV results by comparing to the appropriate specification limits. If QV test results conform to the specification, the department will take no further action. If QV test results are nonconforming, the engineer will compare those results to the nearest previous QC test result as follows:
 1. If the QV and QC results are within the tolerances specified in B.2.2.2, the department will take no further action.
 2. If QV and QC results are not within the tolerances specified in B.2.2.2, add the QV to the QC test results as if it were an additional QC test.

B.2.2.2 Verification Testing Tolerances

- (1) Differences between the contractor's QC test results and the department's QV test results are acceptable if within the following tolerances:

TEST PROPERTY	ACCEPTABLE DIFFERENCE
GRADATION	
1 in (25.0 mm)	±6 % passing
3/4 in (19.0 mm)	±6 % passing
3/8 in (9.5 mm)	±6 % passing
No. 4 (4.75 mm)	±5 % passing
No. 8 (2.36 mm)	±4 % passing
No. 10 (2.00 mm)	±4 % passing
No. 30 (600 µm)	±4 % passing
No. 40 (425 µm)	±4 % passing
No. 50 (300 µm)	±4 % passing
No. 200 (75 µm)	±2 % passing
PERMEABILITY	±20 % of the measured QV permeability
FRACTURE	±10 % of the measured QV fracture

B.2.3 Independent Assurance

- (1) Independence assurance is unbiased testing the department performs to evaluate the department's QV and the contractor's QC sampling and testing including personnel qualifications, procedures, and equipment. The department will perform an IA review according to the department's independent assurance program. That review may include one or more of the following:
 1. Split sample testing.
 2. Proficiency sample testing.

3. Witnessing sampling and testing.
 4. Test equipment calibration checks.
 5. Reviewing required worksheets and control charts.
 6. Requesting that testing personnel perform additional sampling and testing.
- (2) If the department identifies a deficiency, and after further investigation confirms it, correct that deficiency. If the contractor does not correct or fails to cooperate in resolving identified deficiencies, the engineer may suspend placement until action is taken. Resolve disputes as specified in B.4.

B.3 Acceptance

- (1) The department will accept base aggregate based on the contractor QC tests unless it is shown through QV testing or the dispute resolution process that the contractor's test results are in error.

B.4 Dispute Resolution

- (1) The engineer and contractor should make every effort to avoid conflict. If a dispute between some aspect of the contractor's and the engineer's testing program does occur, seek a solution mutually agreeable to the project personnel. The department and contractor may review the data, examine data reduction and analysis methods, evaluate sampling and testing procedures, and perform additional testing. Use ASTM E 178 to evaluate potential statistically outlying data.
- (2) If the project personnel can not resolve a dispute, and the dispute affects payment or could result in incorporating nonconforming product, the department will use third party testing to resolve the dispute. The department's central office laboratory, or a mutually agreed on independent testing laboratory, will provide this testing. The engineer and contractor will abide by the results of the third party tests. The party in error will pay service charges incurred for testing by an independent laboratory. The department may use third party test results to evaluate the quality of questionable materials and determine the appropriate payment. The department may reject material or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

C (Vacant)

D Measurement

- (1) The department will measure QMP Base Aggregate by the ton of aggregate acceptably tested. The department will measure the quantity based on the tonnage placed under the Base Aggregate bid items listed in subsection A. The department will include material placed for temporary base or to maintain local traffic even though it was not sampled during placement. The department will not include material classified as reclaimed asphaltic pavement placed under the Base Aggregate Dense bid items.

E Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
301.0100.S	QMP Base Aggregate	Ton

- (2) Payment is full compensation for all sampling, testing, and documentation required under this special provision. If the contractor fails to perform the work required under this special provision, the department may reduce the contractor's pay. The department will administer pay reduction under the Non-performance on QMP administrative item.
- (3) For material represented by a running average exceeding a control limit, the department will reduce pay by 10 percent of the contract price for the affected Base Aggregate bid items listed in subsection A. The department will administer pay reduction under the Nonconforming QMP Base Aggregate Gradation or Nonconforming QMP Base Aggregate Fracture administrative items. The department will determine the quantity of nonconforming material as specified in B.1.7.3.
- (090105) 301-010

13. Concrete Pavement Fast Track, 11-Inch, Item 415.1150.S.

A Description

This special provision describes construction of fast track concrete pavement in accordance with the standard specifications, as shown on the plans, and as hereinafter provided.

B Materials

B.1 Concrete Mixtures

Concrete mix design shall be the responsibility of the contractor. Delete 501.2.5.4.4 and 501.3.2.3 of the standard specifications. Chloride based accelerators shall be prohibited from use in fast track concrete pavement. Any chemical admixture(s) to be used, other than air-entraining agents or water reducers from the department's approved list, must be approved in advance by the engineer. The water-cement ratio of the concrete mixture shall not exceed 0.40.

C Construction

C.1 Opening to Traffic

Delete 415.3.17 of the standard specifications and replace with the following: Fast track concrete pavement must attain a minimum compressive strength of 3500 psi before it can be opened to traffic. The compressive strength shall be measured by testing concrete cylinders cured in the field on top of the slab, under the curing blanket.

At least two cylinders shall be tested in determining the attained strength of fast track concrete pavement for the purpose of opening the pavement to traffic. The average of test results for the two cylinders shall be used to determine compliance, except that neither cylinder may be less than 10 percent below the required strength.

If opening is not controlled by cylinders, cores may be substituted.

C.2 Test Equipment

In the field laboratory, provide a compressive test machine for use by department staff, and all equipment and materials necessary to perform compressive testing. The compressive test machine shall be an electrically powered unit with a minimum capacity of 200,000 lbs, and shall meet all requirements of ASTM C39. After the machine is set in place in the field laboratory on the project, provide calibration by a qualified vendor in accordance with all requirements of ASTM E4. This vendor shall provide the engineer with a Certificate of Calibration. Recalibration shall be required under any of the conditions covered in Section 5.1.1 of ASTM C39. The contractor will be allowed access to the field laboratory to use the machine for preliminary mix design testing for fast track concrete.

C.3 Concrete Mix Approval Procedure

The following activities shall be completed in advance of the paving date.

1. Perform preliminary laboratory and/or field trial batching to establish the mix proportions necessary to meet the anticipated necessary age-strength properties.
2. Submit an action plan to the engineer for the specified closure period, which shall include the amount of time to be allowed for concrete curing at the conclusion of paving. Also submit to the engineer, at the same time, a proposed mix design (including specific sources and/or trade names as applicable for all materials) for formal mix design acceptance testing using a full scale field trial batch.
3. Execution of the formal full-scale field trial batch for mix design acceptance shall not commence until the engineer has approved the action plan and all components of the proposed mix design.
4. Under supervision of the engineer, cast a test slab of the same thickness as the actual fast track concrete work required on the project. The test slab shall be cast under similar environmental conditions as the actual fast track concrete work required on the project, subject to the approval of the engineer. The test slab shall consist of at least one full batch from the plant that will provide concrete for the project. Department project staff shall cast test cylinders from this batch, and the cylinders shall be cured laying down on top of the test slab under the same type of insulated blanket that will be used for the project. Department staff shall test these cylinders in pairs as the end of the designated curing time approaches, to determine the curing time required to reach the required 3500 psi compressive strength. If the required strength is not reached within the curing time allowed in the action plan, the contractor shall modify the mix and repeat the mix acceptance test. Once a mix design is accepted, all components and proportions of the mix must remain the same for all fast track concrete work on the project, with the exception of minor adjustments of water and air-entraining agent as necessary, or the mix acceptance test must be repeated.

Trial slabs cast for preliminary or formal testing may be cast offsite, or incorporated in the work in place of standard concrete pavement, subject to approval of the engineer. Any test slabs so incorporated in the work must meet pertinent requirements for standard concrete pavement, and the contractor shall be paid the bid unit price for standard concrete pavement of the same nominal thickness. Any test slabs cast offsite shall become the property of the contractor.

C.4 Curing Blankets

As soon as possible after surface texturing and application of curing compound and without damage to the pavement surface, cover the concrete with impermeable insulating blankets with an R value of at least 0.09. The blankets shall remain in place until the concrete has reached 3500 psi compressive strength. The blankets may be temporarily turned back for the minimum time necessary to facilitate joint sawing.

D Measurement

The department will measure Concrete Pavement Fast Track (inch) by area in square yards, completed in accordance with the contract and accepted.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
415.1150.S	Concrete Pavement Fast Track 11-Inch	SY

Payment is full compensation for furnishing and calibrating test equipment; developing mix designs; placing test slabs and furnishing test slab materials when placed offsite; furnishing, hauling, preparing, placing, curing and protecting of all materials except pavement ties and dowel bars which are installed in the existing concrete pavement; sawing joints; preparing the foundation; backfilling; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the contract work.

(082003) 415-010

14. QMP Concrete Pavement, Item 415.3000.S; Incentive Strength Concrete Pavement, Item 415.2000.S.

A Description

A.1 General

- (1) Conform to 320, 415, 416, and 501 of the standard specifications as modified in this special provision. Apply this special provision only to the following bid items:

320.0100 - 0199	Concrete Base (inch)
320.0300 - 0399	Concrete Base HES (inch)
320.0500	Concrete Base Widening
415.0060 - 0199	Concrete Pavement (inch)
415.1080 - 1199	Concrete Pavement HES (inch)
416.0050	Concrete Pavement Approach Slab
416.0055	Concrete Pavement Approach Slab HES

416.0310	Concrete Alley
416.0315	Concrete Alley HES
416.0410	Concrete Pavement Header
416.0415	Concrete Pavement Header HES
416.0805	Concrete Pavement Gaps

- (2) Provide and maintain a quality control program, defined as all activities and documentation of the following:
 1. Mix design.
 2. Production control, placement control, and inspection.
 3. Sampling, testing, measurement, and correction of materials and in-place concrete pavement.
- (3) Chapter 4 of the department's construction and materials manual (CMM) provides additional detailed guidance for QMP work and describes required sampling and testing procedures. The contractor may obtain the CMM from the department's extranet site at:

<https://trust.dot.state.wi.us/extntgtwy/dtidcons/constnds/cmm/cmm.htm>

A.2 Contractor Testing for Small Quantities

- (1) The department defines a small quantity, for a particular mix design and placement technique, as less than 2500 cubic yards (1912 m³) for slip-formed work or 1000 cubic yards (765 m³) work not slip-formed.
- (2) The requirements under this special provision apply equally to a small quantity for a particular mix design and placement technique except as follows:
 1. The contractor need not submit a full quality control plan but shall provide an organizational chart to the engineer including names, telephone numbers and current certifications of all persons involved in the quality control program.
 2. The engineer may accept aggregate gradation based upon satisfactory records of previous testing.
 3. No concrete control charts are required. Submit test results to the engineer each day as they become available. Assure that all properties are within the limits specified in the standard specifications for each subplot tested.
 4. The department will not adjust the pay for sublots with conforming compressive strength.

B Quality Control Program Requirements

B.1 Quality Control Plan

- (1) Submit a comprehensive written quality control plan. Construct the project as the plan provides. Submit the plan to the engineer no later than 10 business days before placing concrete pavement. Do not change the quality control plan without the engineer's review. Update the plan with changes as they become effective. Provide a current copy of the plan to the engineer and post in each of the contractor's laboratories before producing concrete and as changes are adopted. Ensure that the plan provides the following elements:

1. An organizational chart including names, telephone numbers, current certifications and/or titles, and roles and responsibilities of all quality control personnel.
2. The process by which quality control information and corrective action efforts will be disseminated to the appropriate persons. Include a list of recipients, the communication means that will be used, and action time frames.
3. Preliminary concrete pavement mix information including anticipated producers, manufacturers, and sources of mix materials, and the name, title, and phone number of the person responsible for developing the mix design.
4. The locations of the QC laboratories for mix design, aggregate testing, cylinder curing, concrete testing, and compressive strength testing.
5. Anticipated concrete mix aggregate gradations and limits.
6. The initial and routine equipment checks and documentation performed on scales, and water meters.
7. The methods for monitoring and recording the materials used in each batch.
8. Procedures for documenting the locations of yielding base course and subgrade.
9. The frequency of contractor quality control testing, if planning to perform more frequently than section B.7 specifies.
10. The format for control charts and sampling, testing, and pay adjustment data documentation, if different from the forms provided in the CMM 4-15-42.

B.2 Personnel Requirements

- (1) Perform the material sampling, testing, and documentation required under this provision using HTCP certified technicians. Have a PCC technician certified under HTCP at level I present at the project site, prepared and equipped to perform required sampling and testing, whenever placing concrete.

B.3 Laboratory Requirements

- (1) Perform the concrete mix design, aggregate testing, cylinder curing, and compressive strength testing at a department-qualified laboratory. Obtain information on the Wisconsin laboratory qualification program from:

Quality Management Section

3502 Kinsman Blvd.

Madison Wisconsin 53704

Telephone: 608-246-3246

<http://www.dot.state.wi.us/business/engrserv/lab-qualification.htm>

B.4 Equipment Requirements

- (1) Furnish the necessary equipment and supplies for performing quality control testing. The engineer may inspect the measuring and testing devices to confirm both calibration and condition. Calibrate all testing equipment according to the CMM 4-15-12 and maintain a calibration record at the laboratory.

B.5 Concrete Pavement Mixes

B.5.1 General

- (1) Determine concrete pavement mixes for the project.
- (2) For concrete base, use a grade B, B-FA, B-S, B-IS, or B-IP concrete mix conforming to section 501 of the standard specifications. The contractor may substitute aggregate conforming to the gradation requirements of a contractor-developed pavement mix design approved under the contract.

B.5.1.1 Mix Development

- (1) Have a PCC technician certified under HTCP at level II develop contractor-supplied pavement mixes. Test concrete during mix development at a department-qualified laboratory.

B.5.1.2 Submittal and Review Procedures

- (1) At least 5 business days before producing concrete, submit to the engineer 2 copies of a concrete pavement mix report. Include signature blocks for both the contractor's mix developer and the department's project engineer on the mix report cover sheet. Before the engineer's review, have the mix developer sign and date each copy attesting that all information in the report is accurate and true. The engineer will review, comment, sign, and date each copy of the report. The engineer's signature will verify that the engineer had the opportunity to review the mix report, to check that it meets the concrete mix requirements, and to comment. The engineer will keep one original signed copy and return the other copy to the contractor within 5 business days of receiving the report.

B.5.2 Standard Specification Concrete Mix

- (1) Replace the word "engineer" with the word "contractor" in 501.3.2.1. and 501.3.2.3. of the standard specifications.
- (2) The contractor may elect to use concrete pavement mixes from section 501 of the standard specifications. When choosing this alternate, the contractor is responsible for mix performance just as if the contractor provided independent mix designs.
- (3) Provide mix documentation ensuring that all materials conform to section 501 of the standard specifications unless the engineer waives specific requirements. Ensure that the mix limits, including aggregate gradations, are within the master limits listed in 501.3.2.2 of the standard specifications. Include documentation for the original mix designs as follows:
 1. Mix: proportions, batch weights, and the water to cementitious material ratio.
 2. Materials: type, brand, and source.
 3. Aggregates: absorption, specific gravities, wear, soundness, freeze thaw test results if required, air correction factor, and proposed gradation control limits.

B.5.3 Contractor Concrete Mix Design

- (1) Delete 501.2.5.3.4, 501.2.5.4.4, 501.3.1.1.2, 501.3.2.1, 501.3.2.2, and 501.3.2.3 of the standard specifications. Delete the maximum limit for percent passing the No. 200 (75 μm) sieve from 501.2.5.3.1 and 501.2.5.4.2 of the standard specifications.

B.5.3.1 Documentation

- (1) Provide mix design documentation ensuring that all materials conform to 501.2 of the standard specifications, as modified in this special provision, unless the engineer waives specific requirements. Include documentation for contractor mix designs as follows:
 1. Mix development: test dates, the name and location of the laboratory used to develop the mix design.
 2. Mix: proportions, batch weights, water to cementitious material ratio, air content, and 28-day or earlier compressive strength.
 3. Materials: type, brand, and source.
 4. Aggregates: absorption, specific gravities, wear, soundness, freeze thaw test results if required, air correction factor, and proposed gradation control limits.

B.5.3.2 Mix Design Physical Requirements

- (1) Use at least 5 pairs of tests cylinders to demonstrate the compressive strength of a mix design. The contractor may report strengths from either laboratory testing or previous field test data for a similar mix design. Ensure that the average compressive strength achieved, in 28 days or less, by the 5 pairs of cylinders is 4200 psi (29 MPa) or greater. The contractor need not provide separate laboratory mix designs and compressive strength tests for high early strength concrete.
- (2) Provide a minimum cement content of 565 pounds per cubic yard (335 kg/m^3), except if using type I or III cement in a mix where the geologic composition of the coarse aggregate is primarily igneous or metamorphic materials, provide a minimum cement content of 660 pounds per cubic yard (392 kg/m^3). The contractor may partially replace Portland cement with fly ash at a replacement ratio of not less than one pound (kg) of fly ash per one pound (kg) of cement up to a maximum fly ash content of 30% of total cementitious material. Alternatively, the contractor may use slag as a partial replacement for cement at a replacement ratio of not less than one pound (kg) of slag per 1.0 one pound (kg) of cement. For slip-formed concrete pavement do not exceed a maximum slag content of 50% of the total cementitious material. For concrete pavement not slip-formed, do not exceed a maximum slag content of 30% of total cementitious material. Alternatively, the contractor may use a combination of fly ash and slag up to a maximum combined fly ash and slag content of 30 percent. Ensure that fly ash conforms to 501.2.6 and slag conforms to 501.2.7 of the standard specifications.
- (3) For mix design, ensure that the ratio of water to total cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates, is not more than 0.42 by weight.

- (4) Provide aggregate conforming to the following:
 - 1. One hundred percent of the aggregate shall pass the 2 inch (50 mm) sieve.
 - 2. The percent of total aggregate passing the No. 200 (75 μ m) sieve shall not exceed 2.3 percent, by weight.
 - 3. The total aggregate passing the No. 4 (4.75 mm) sieve shall not exceed 42 percent, by weight; except, if the coarse aggregate is completely composed of crushed stone and/or recycled concrete, the total aggregate passing the No. 4 (4.75 mm) sieve shall not exceed 47 percent, by weight.
- (5) Do not use chloride based accelerators in mixes for all new construction.
- (6) The contractor may adjust admixture dosages without providing a new mix design.

B.5.4 Mix Changes

- (1) Prepare and submit modifications to a standard specification concrete mix or a contractor concrete mix design to the engineer for review before using that mix. Modifications requiring the engineer's review include changes in:
 - 1. The source of any material.
 - 2. The amounts of cementitious materials.
 - 3. The adjustment of fine to total aggregate greater than ± 3 percent by weight.
 - 4. The addition or deletion of admixtures.
- (2) When the department requires or allows high early strength concrete, use type III cement. Alternatively the contractor may add a minimum of an additional 95 pounds of cement per cubic yard of concrete (57 kg cement/m³ concrete) to a previously accepted mix.

B.6 Quality Control Documentation

B.6.1 Control Charts

- (1) Maintain control charts when required by the test reporting procedures. Ensure that all test results are recorded and become part of the project records. Only include the contractor's QC test results in the 4-point running average plotted on the control charts. The contractor may plot test results of other contractor-performed process control or informational test results on the control charts, but do not include them in 4-point running averages.
- (2) Post control charts in an engineer-approved location and update daily. Ensure that the control charts include the project number, the test number, each test element, the applicable warning and control limits, the contractor's individual test results, the running average of the last 4 data points, and the engineer's verification and independent assurance test data points. Use the control charts as part of a process control system for identifying potential problems and assignable causes. Format control charts according to CMM 4-15-12.

B.6.2 Records

- (1) Document all observations, inspection records, mix adjustments, and test results daily. Submit original testing records and control charts to the engineer in a neat and orderly manner within 10 days after completing concrete production.

B.7 Required Quality Control Testing

B.7.1 General

- (1) Perform all quality control tests necessary to control the production and construction processes applicable to this special provision and as described in the quality control plan. Use the test methods identified below, or other methods the engineer approves, to perform the following tests:
 - Aggregate gradations AASHTO T-11^[1] & T-27^[1]
 - Aggregate materials finer than the No. 200 sieve AASHTO T 11^[1]
 - Aggregate moisture AASHTO T 255^[1]
 - Air content AASHTO T 152^[2]
 - Slump AASHTO T 119^[2]
 - Temperature AASHTO T 309
 - Compressive strength AASHTO T 22, T 23, T 141, M 201

^[1] As modified in CMM 4-25-50.

^[2] As modified in CMM 4-25-70.
- (2) The department may periodically observe contractor sampling and testing, and direct additional contractor sampling and testing for department evaluation. Ensure that all test results are available for the engineer's review at any time during normal working hours.

B.7.2 Aggregate Gradation Testing

B.7.2.1 Sampling and Testing

- (1) Randomly sample and test the individual aggregate gradations according to AASHTO T 11 and AASHTO T 27 as modified by the department. Have an HTCP certified aggregate sampling technician, aggregate technician I or IPP, or PCC technician IA perform all sampling. Have an HTCP certified aggregate technician I or IPP test the aggregate and document the results. Test during aggregate production as follows:

Daily Aggregate Production, Rate in tons or Mg	Minimum Testing Frequency for Each Aggregate Stockpile
≤1000	One test per cumulative total of 1000 tons or Mg; or a minimum of one test per 5 days of aggregate production
>1000 - ≤2000	2 tests per day
>2000+	3 tests per day

- (2) If the aggregate was produced before the contract and production records are not available or not acceptable to the engineer, sample and test during concrete production at a frequency greater than or equal to the following:

Daily Concrete Production in cubic yards (m ³)	Minimum Testing Frequency for Each Aggregate Stockpile
≤250 (200)	One test per cumulative total of 250 cy (200 m ³) or a minimum of one test per 5 days of concrete production
>250 (200) - ≤1000 (750)	One test per day
>1000 (750)	2 tests per day

- (3) Ensure that only results of randomly selected QC tests are included in the 4-point running average.
- (4) Wash each sample of fine aggregate. Also wash the first 4 samples of each of the coarse aggregates. If the percent passing the No. 200 (75 µm) sieve for the coarse aggregate is less than the warning limit, wash at least every 10th sample of each of the coarse aggregates. If the percent passing the No. 200 (75 µm) sieve for the coarse aggregate is greater than or equal to the warning limit, wash each sample of the coarse aggregate until 4 consecutive tests are less than the warning limit.
- (5) Use control limits for sieve sizes as identified by the contractor in the project concrete mix report or, if the concrete mix report is not published at the time of testing, in the contractor's quality control plan. Gradation warning limits are inside the upper and lower control limit values by one percentage point for all sieves except as follows:
 1. The upper warning limits for percent passing the No. 100 (150 µm) and No. 200 (75 µm) sieves are inside the control limit by 0.5 percent.
 2. For sieves allowing 100 percent passing, there is no upper warning limit. For sieves with 0 percent passing, there is no lower warning limit.

B.7.2.2 Documentation

- (1) Maintain control charts at the laboratory for each aggregate stockpile. Maintain a chart for each control sieve for each material. Record contractor test results the same day tests are conducted.

B.7.2.3 Corrective Action

- (1) When the 4-point running average value approaches a warning limit, consider corrective action. Ensure that any corrective action is documented and becomes part of the project records.
- (2) Document whenever a 4-point running average exceeds the warning limits. When a second consecutive running average value exceeds the warning limits, take corrective action. Continue corrective action until 2 consecutive average points are within the warning limits.
- (3) Notify the engineer whenever an individual test value exceeds a control limit. Material is nonconforming when an individual test result exceeds the control limit. The quantity of nonconforming material includes the material of the first test result exceeding the control limit, continuing to but not including, the material from the first subsequent

test result that is within the control limits. The department may reject material or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

B.7.3 Aggregate Percent Passing the No. 200 Sieve Testing

B.7.3.1 Sampling and Testing

- (1) Have an HTCP certified aggregate sampling technician, aggregate technician I or IPP, or PCC technician IA perform all sampling. Ensure that an HTCP certified PCC technician IA or a technician with both PCC technician I and aggregate technician I or IPP certifications performs all testing and documentation.
- (2) Measure and record the percent passing the No. 200 (75 μ m) sieve of both the fine and course aggregates when producing concrete pavement. Conduct tests according to AASHTO T 11 as modified by the department. Test at least one sample as early as it is practical each day and as mix or material conditions change. The contractor may reduce this testing frequency, if the engineer approves, but maintain at least one test per 5 days of concrete production.
- (3) Document testing as specified in B.6.1, B.7.2.1, and B.7.2.2, by developing a combined gradation control chart for the percent passing the No. 200 (75 μ m) sieve. Use the control limits defined in the concrete pavement mix report. Ensure that only results of QC tests are included in the 4-point running average.

B.7.3.2 Corrective Action

- (1) When an individual test approaches a warning limit, consider corrective action. Document corrective actions and include that documentation in the project records.
- (2) Notify the engineer if an individual test exceeds the warning limits. If a second consecutive individual test exceeds the warning limits, the engineer and contractor will determine the contractor's course of corrective action. If the corrective action improves the property in question such that additional individual tests are within the warning limits, the contractor may continue production. If the correction does not improve the property, and new individual tests stay in the warning band, repeat the steps outlined here in B.7.3.2(2) starting with notifying the engineer.
- (3) Notify the engineer whenever an individual test value exceeds a control limit. Material is nonconforming when an individual test result exceeds the control limit. The quantity of nonconforming material includes the material of the first test result exceeding the control limit, continuing to but not including, the material from the first subsequent test result that is within the control limits. The department may reject material or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

B.7.4 Compressive Strength

- (1) The department will adjust pay and base concrete acceptance on the compressive strength of concrete cylinders. The department will not adjust pay for concrete base or

for high early strength concrete. Include tests of concrete base and high early strength concrete for all other QC testing, except no 28-day cylinders are required for concrete base or for high early strength concrete.

B.7.4.1 Concrete Sampling

B.7.4.1.1 General

- (1) The department will adjust pay for compressive strength on a lot-by-lot basis. The department will accept or reject concrete on a subplot-by-subplot basis. Designate the approximate location and size of all lots before placing concrete pavement. Ensure that no single lot contains concrete of more than one mix design, as defined in B.5, or more than one placement technique. Divide each lot into 5 or more sublots. Determine the approximate number and size of sublots before placing any concrete in that lot. Do not cast more than one set of cylinders from a single truckload of concrete. Incorporate material from any partial subplot left unsampled at the end of any day into the previous subplot for acceptance. Material from any partial subplot the contractor samples will stand on its own as a partial subplot for acceptance.
- (2) Have an HTCP certified PCC technician I or IA sample, test, and document results during concrete production and placement. Cast one set of 2 or 3 standard 6X12 inch cylinders for each subplot using concrete delivered to the job site. Cast the number of cylinders per subplot the contractor's quality control plan designates. Cast all subplot cylinders from the same sample. Have a certified technician determine random subplot sampling locations as described in CMM 4-15-12. Sample according to AASHTO T 141. Cast and initially cure the cylinders according AASHTO T 23.
- (3) Fabricate one set of 2 or 3 companion cylinders for department testing during each day of concrete production from a subplot the engineer designates. Cast the same number of companion cylinders as QC cylinders cast for that subplot. Use the same concrete sample as used for the contractor's QC cylinders for that subplot. Provide all materials, fabrication, initial curing, and handling required for companion cylinders for up to 3 days following fabrication.

B.7.4.1.2 Slip-Formed

- (1) A lot typically consists of the amount of concrete pavement placed during each day's paving.
- (2) Divide each lot into standard sublots. Define the standard subplot size in the quality control plan, but do not exceed 500 cubic yards (382m³).
- (3) If less than 5 random samples are collected in a day, incorporate the represented concrete into the following or previous day's pavement lot.

B.7.4.1.3 Not Slip-Formed

- (1) Do not exceed a lot size of 1000 cubic yards (765 m³).

- (2) Define at least one subplot per day per mix grade placed. Do not exceed a subplot size of 200 cubic yards (153 m³).

B.7.4.2 Concrete Cylinder Curing

- (1) Provide facilities for initial curing. For up to 48 hours after casting, maintain the temperature adjacent to the specimens in the range of 60 to 80 degrees F (16 - 27 degrees C) and prevent moisture loss. Between 24 and 48 hours after casting, transport the specimens to a department-qualified laboratory for standard curing according to AASHTO M 201 for 28 days.

B.7.4.3 Compressive Strength Testing

- (1) Have an HTCP certified compressive strength tester, in a department-qualified laboratory, perform compressive strength testing and document the results. Determine the 28-day compressive strength in psi of each cylinder according to AASHTO T 22. The subplot strength is the average compressive strength of 2 subplot QC test cylinders chosen by the contractor. If the contractor casts 3 cylinders per subplot, and after breaking 2 cylinders the strength of the lower strength cylinder is less than 90% of the higher strength cylinder, also break the third cylinder. Discard the lowest of the 3 cylinders and calculate the subplot strength as the average of the 2 higher strength cylinders.
- (2) Test each cylinder to failure. Use a compression machine that automatically records the date, time, rate of loading, and maximum load of each cylinder. Include a printout of this information with the compressive strength documentation for each cylinder cast for the subplot.

B.7.4.4 Removal and Replacement

- (1) If a subplot strength is less than 2500 psi (17.2 MPa), the department may direct the contractor to core that subplot to determine its structural adequacy and whether to direct removal. Cut and test cores according to AASHTO T 24 as and where the engineer directs. Have an HTCP certified PCC technician I perform or observe the coring. Bear all coring and testing costs, fill all core holes with an approved grout, and provide traffic control during coring at no cost to the department.
- (2) The subplot pavement is conforming if the compressive strengths of all cores from the subplot are 2500 psi (17.2 MPa) or greater or the engineer does not require coring. The department will allow conforming material to remain in place and use the original cylinder strength results in the calculation for the lot pay adjustment as specified in G.3.
- (3) The subplot pavement is nonconforming if the compressive strengths of any core from the subplot is less than 2500 psi (17.2 MPa). The department may direct removal and replacement or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

B.7.5 Air Content

- (1) On each day of production, test the concrete air content as early and as frequently as it is practical until the concrete meets the specifications and the production process is under control. Subsequently, test air content for each compressive strength subplot. Have an HTCP certified PCC technician I or IA test air content according to AASHTO T 152, as modified by the department. Test concrete taken from the same sample used for QC strength cylinders, and as the engineer directs.
- (2) The lower and upper control limits for air content are the values specified in 501.3.2.4.2. of the standard specifications. The lower warning limit for air content is 0.5 percent above the lower control limit. There is no upper warning limit.

B.7.5.1 Documentation

- (1) Maintain a control chart at a fixed location on the project site. Ensure that all test results are recorded and become part of the project records. Chart all results on the same day tests are conducted. Only plot results of samples selected randomly in the 4-point running average.
- (2) Document admixture dosage rates, time of day, and air temperature on the combined gradation control chart for the percent passing the No. 200 (75 μ m) sieve whenever changing an admixture dosage rate.

B.7.5.2 Corrective Action

- (1) If an individual air test is between the lower warning limit and lower control limit, double the air content test frequency to 2 tests per compressive strength subplot. Perform one of these tests from the same concrete sample used for the QC strength cylinders. Select the second sample randomly from the half of the subplot not used for the QC strength cylinders. Determine both random test locations within a subplot before paving that subplot. Continue testing at increased frequency until an individual test point is above the lower warning limit and below the upper control limit.
- (2) When the 4-point running average value trend is towards the lower warning limit or the upper control limit, consider corrective action.
- (3) Notify the engineer if a 4-point running average is less than the lower warning limit. If a second consecutive running average is below the warning limit, the engineer and contractor will determine the contractor's course of corrective action. If the corrective action improves the property in question such that the new running average, after four additional individual tests, is between the lower warning limit and upper control limit, the contractor may continue production. If the new running average is below the lower warning limit, repeat the steps outlined here in B.7.5.2(3) starting with notifying the engineer.
- (4) If an individual air test is outside the control limits, notify the engineer, and perform additional air tests as often as it is practical on subsequent loads until the air content is inside the control limits. The material is nonconforming when an individual test result

exceeds the control limit. Material from the load with the first test exceeding the control limit, continuing to but not including the load with the first subsequent test within the control limits, is nonconforming. The department may direct removal and replacement or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

B.7.6 Concrete Temperature

- (1) Have an HTCP certified PCC technician I or IA measure concrete temperature according to AASHTO T 309. Test concrete taken from the same sample used for QC strength cylinders. Record concrete temperatures on the air content control chart.

B.7.7 Slump

- (1) Have an HTCP certified PCC technician I or IA measure slump according to AASHTO T 119. The contractor need not test slump for slip-form paving unless the engineer requests. For other placement techniques, test slump at the same frequency and from the same sample as used for strength cylinders and as the engineer directs. Provide material conforming to the slumps specified in 415.3.6 of the standard specifications.

C Department Testing

C.1 General

- (1) The department will conduct verification testing to validate the quality of the product and independent assurance testing to evaluate the sampling and testing. The department will provide the contractor with a listing of names and telephone numbers of all verification and independent assurance personnel for the project.
- (2) Except for strength, the department will provide test results to the contractor within 2 business days after the department obtains the sample.

C.2 Verification Testing

- (1) The department will have an HTCP technician, or ACT under the direction of a certified technician, perform QV sampling and testing. Department verification testing personnel must meet the same certification level requirements specified for contractor testing personnel for each test result being verified. The department will notify the contractor before sampling so the contractor can observe QV sampling.
- (2) The department will sample randomly at locations independent of the contractor's QC work. In all cases, the department will conduct the verification tests in a separate laboratory and with separate equipment from the contractor's QC tests.
- (3) The department will perform verification testing as follows:

	Testing Frequency Guide ^[1]	Sampling Material and Location	Test Method	Alternate Test Methods
Air content	1 per lot	Plastic concrete, ahead or behind ^[2] the paver	AASHTO T 152 as modified	Hardened air content testing ^[2] after construction
28-day compressive strength	1 per 5 lots	Cylinders	AASHTO T 22, T 23 & T 141 as modified	Random cores ^[2] after construction

^[1] The engineer may increase the frequency at start-up or as necessary to validate the quality of the materials. The engineer may reduce the frequency based on a history of satisfactory contractor or material performance.

^[2] Evaluation of test results should account for systematic differences in testing methods or sampling locations.

- (4) The department will conduct verification testing for pavement thickness as specified in 415.3.18. of the standard specifications.
- (5) Plot verification test results on the contractor's quality control charts as specified in B.6.1. Do not include verification test results in the 4-point running average.
- (6) If verification tests indicate conformance with specifications, no further action is required. If verification tests indicate nonconformance with specifications, the engineer and contractor will jointly investigate any testing discrepancies. The investigation may include additional testing as well as review and observation of both the department's and contractor's sampling and testing procedures and equipment. Both parties will document all investigative work.
- (7) Correct all deficiencies. If the contractor does not respond to an engineer request to correct a deficiency or resolve a testing discrepancy, the engineer may suspend production until action is taken. Resolve disputes as specified in D.

C.3. Independent Assurance Testing

- (1) Independence assurance is unbiased testing the department performs to evaluate the department's verification and the contractor's QC sampling and testing including personnel qualifications, procedures, and equipment. The department will perform the independent assurance review according to the department's independent assurance program, which may include one or more of the following:
 1. Split sample testing.
 2. Proficiency sample testing.
 3. Witnessing sampling and testing.
 4. Test equipment calibration checks.
 5. Reviewing required worksheets and control charts.
 6. Requesting that testing personnel perform additional sampling and testing.

- (2) Plot the independent assurance test results on the contractor's quality control charts as specified in B.6.1. Do not include independent assurance test results in the 4-point running average.
- (3) If the department identifies a deficiency, and after further investigation confirms it, correct that deficiency. If the contractor does not correct or fails to cooperate in resolving identified deficiencies, the engineer may suspend production until action is taken. Resolve disputes as specified in D.

D Dispute Resolution

- (1) The engineer and contractor should make every effort to avoid conflict. If a dispute between some aspect of the contractor's and the engineer's testing program does occur, seek a solution mutually agreeable to the project personnel. The department and contractor may review the data, examine data reduction and analysis methods, evaluate sampling and testing procedures, and perform additional testing. Use ASTM E 178 to evaluate potential statistically outlying data.
- (2) If the project personnel can not resolve a dispute and the dispute affects payment or could result in incorporating nonconforming product, the department will use third party testing to resolve the dispute. The department's central office laboratory, or a mutually agreed on independent testing laboratory, will provide this testing. The engineer and contractor will abide by the results of the third party tests. The party in error will pay service charges incurred for testing by an independent laboratory. The department may use third party test results to evaluate the quality of questionable materials and determine the appropriate payment. The department may reject material or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

E Acceptance

- (1) The department will accept concrete pavement based on the contractor QC tests unless it is shown through the verification, or the dispute resolution process that the contractor's test results are in error.

F Measurement

- (1) The department will measure QMP Concrete Pavement by the day for QC testing acceptably completed. The department will measure, in 1/2 day increments, the time spent placing concrete under the bid items listed in A.1. The department will measure 1/2 day for 4 hours or less of concrete paving and one day for greater than 4 hours of concrete paving. The department will only measure the QMP Concrete Pavement bid item if all of the following conditions are met:
 1. The contractor is placing concrete pavement.
 2. QC sampling and testing is required under the contract.
 3. All required sampling and testing is performed.

- (2) If these conditions are met, the department will measure paving time beginning when the first truckload of concrete is discharged and ending when the last truck discharges its concrete. The department will start and stop measurement of paving time based on the start and stop of the contractor's paving operations.
- (3) If the contractor demonstrates, to the engineer's satisfaction, that it is necessary to use more than one testing crew during multiple paving operations, the department will measure time for each testing crew working concurrently.
- (4) The department will measure Incentive Strength Concrete Pavement by the dollar, adjusted as specified in G.3.

G Payment

G.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
415.3000.S	QMP Concrete Pavement	DAY
415.2000.S	Incentive Strength Concrete Pavement	DOL

G.2 QMP Testing

- (1) Payment for QMP Concrete Pavement is full compensation for all sampling, testing, and documentation required under this special provision. If the contractor fails to perform the work required under this special provision, the department may reduce the contractor's pay. The department will administer pay reduction under the Non-performance of QMP administrative item.

G.3 Pay Adjustment for Strength

- (1) The department will pay incentive for compressive strength under the Incentive Strength Concrete Pavement bid item. Incentive payment is not limited, either up or down, to the amount the schedule of items shows.
- (2) The department will administer disincentives for compressive strength under the Disincentive Strength Concrete Pavement administrative item.
- (3) Pay adjustment is based on contractor quality control testing unless alternate data is required to resolve disputed test results. Submit documentation for pay adjustment as soon as strength test results are available using CMM 4-15-42 WS 4151.
- (4) The department will adjust the pay for each lot as follows:
 1. The department will determine the lot average strength and sample standard deviation according to CMM 4-15-42 figure 1. The department will not include results from sublots with air content less than the lower control limit. The department will weight results from all other full, partial, or combined sublots equally. The department will include the subplot strength tests less than 2500 psi (17.2 MPa) if the material is left in place.

2. The department will adjust pay based on the lot average strength minus one standard deviation as follows:

Lot Average - SD (psi)		Pay Adjustment (Dollars/SY)	Lot Average - SD (psi)		Pay Adjustment (Dollars/SY)
Greater Than or Equal To	Less Than		Greater Than or Equal To	Less Than	
2850	2850	-0.55	3750	3850	+0.07
2850	2950	-0.53	3850	3950	+0.13
2950	3050	-0.45	3950	4050	+0.17
3050	3150	-0.39	4050	4150	+0.20
3150	3250	-0.31	4150	4250	+0.23
3250	3350	-0.23	4250	4350	+0.24
3350	3450	-0.17	4350	4450	+0.26
3450	3550	-0.11	4450	4550	+0.27
3550	3650	-0.05	4550	4650	+0.27
3650	3750	0.00	4650		+0.28

- (5) The department will apply the disincentive pay adjustment to the total area of the strength lot. The department will not pay incentive for any quantity of concrete incorporated into the work with air content or slump outside the limits specified in B.7.5 and B.7.7.
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15. QMP Concrete Ancillary.

A Description

- (1) Conform to 390, 416, 501, 509, 510, 601, 602, 603, 604, 611, 620, 636, and 654 of the standard specifications as modified in this special provision. Apply this special provision to all concrete cast in place under these designated sections, except for section 416. For section 416 apply only to concrete placed under the following bid items:
- | | |
|-----------------|--------------------------------|
| 416.0060 | Concrete Pavement Widening |
| 416.0065 | Concrete Pavement Widening HES |
| 416.0160 - 0199 | Concrete Driveway (inch) |
| 416.0260 - 0299 | Concrete Driveway HES (inch) |
| 416.0505 | Pavement Terminal Units |
| 416.0710 | Concrete Pavement Repair |
| 416.0715 | Concrete Pavement Repair SHES |
| 416.1010 | Concrete Surface Drains |
| 416.1015 | Concrete Surface Drains HES |
- (2) Provide and maintain a quality control program, defined as all activities and documentation of the following:

1. Mix design.
 2. Production control, placement control, and inspection.
 3. Sampling, testing, measurement, and correction of materials and in-place concrete.
- (3) The contractor may include ancillary concrete in a quality control program required for concrete pavement or structural concrete.
- (4) Chapter 4 of the department's construction and materials manual (CMM) provides additional detailed guidance for QMP work and describes required sampling and testing procedures. The contractor may obtain the CMM from the department's extranet site at:
- <https://trust.dot.state.wi.us/extntgtwy/dtidcons/constnds/cmm/cmm.htm>

B Quality Control Program Requirements

B.1 Personnel Requirements

- (1) Perform the material sampling, testing, and documentation required under this provision using HTCP certified technicians. Have a PCC technician certified under HTCP at level I present at the project site, prepared and equipped to perform required sampling and testing, whenever placing concrete. Provide an organizational chart to the engineer including names, telephone numbers, and current certifications of all personnel involved in the quality control program.

B.2 Laboratory Requirements

- (1) Perform the cylinder compressive strength testing at a department-qualified laboratory. Obtain information on the Wisconsin laboratory qualification program from:
- Quality Management Section
3502 Kinsman Blvd.
Madison Wisconsin 53704
Telephone: 608-246-3246
<http://www.dot.state.wi.us/business/engrserv/lab-qualification.htm>

B.3 Equipment Requirements

- (1) Furnish the necessary equipment and supplies for performing quality control testing. The engineer may inspect the measuring and testing devices to confirm both calibration and condition. Calibrate all testing equipment according to CMM 4-15-12 and maintain a calibration record at a location satisfactory to the engineer.

B.4 Concrete Mixes

B.4.1 Initial Mix

- (1) Determine concrete mixes for the project. Use concrete mixes from section 501 of the standard specifications. Alternatively, where one of the grade A mixes is allowed under 501.3.1.3 of the standard specifications, the contractor may use a QMP mix design approved for concrete pavement or structural concrete under this contract.

- (2) At least 5 business days before producing concrete, submit concrete mix documentation to the engineer for approval. Provide documentation ensuring that all materials conform to 501.2 of the standard specifications unless the engineer waives specific requirements. Include documentation for mix designs as follows:
 1. Mix grade designation for standard specification mixes.
 2. Materials: type, brand, and source.
 3. Aggregates: absorption, specific gravities, wear, soundness, freeze thaw test results if required, air correction factor, and proposed gradation control limits.

B.4.2 Mix Changes

- (1) Prepare and submit modifications to a standard specification concrete mix or a contractor concrete mix design to the engineer for approval before using that modified mix. Modifications requiring the engineer's approval include changes in:
 1. The source of any material.
 2. The amounts of cementitious materials.
 3. The adjustment of fine to total aggregate greater than ± 3 percent by weight.
 4. The addition or deletion of admixtures.

B.5 Quality Control Documentation

- (1) Document all observations, inspection records, mix adjustments, cylinder identification, and test results daily according to CMM 4-15-42. Submit a copy of the ancillary concrete daily test report to the engineer each day. Submit original testing records to the engineer in a neat and orderly manner within 10 days after completing concrete production.

B.6 Required Quality Control Testing

B.6.1 General

- (1) Perform all quality control tests necessary to control the production and construction processes applicable to this special provision. Use the test methods identified below, or other methods the engineer approves, to perform the following tests:

Aggregate gradations	AASHTO T 11 ^[1] and T 27 ^[1]
Air content	AASHTO T 152 ^[2]
Slump	AASHTO T 119 ^[2]
Temperature	AASHTO T 309
Compressive strength.....	AASHTO T 22, T 23, T 141, M 201

 - ^[1] As modified in CMM 4-25-50.
 - ^[2] As modified in CMM 4-25-70.
- (2) The department may periodically observe contractor sampling and testing, and direct additional contractor sampling and testing for department evaluation. Ensure that all test results are available for the engineer's review at any time during normal working hours.
- (3) Randomly choose sample locations using the procedures described CMM 4-15-12. Use whichever combination of the following criteria resulting in the greatest number of tests.

1. A minimum of one test per day per mix grade.
2. A minimum of one test per 100 cubic yards for each grade of mix placed.
3. For deck overlays, one test per 20 cubic yards of grade E concrete placed.

B.6.2 Compressive Strength

B.6.2.1 Concrete Sampling

- (1) Have an HTCP certified PCC technician I or IA sample, test, and document results during concrete production and placement. Cast a minimum of one set of 2 standard 6x12-inch cylinders for each test using concrete delivered to the job site. Cast all cylinders in a set from the same sample. Sample according to AASHTO T 141. Cast and field cure the cylinders according AASHTO T 23.

B.6.2.2 Opening Strength Testing

- (1) Have an HTCP certified compressive strength tester, in a department-qualified laboratory, perform compressive strength testing and document the results. Determine the compressive strength in pounds per square inch of each cylinder according to AASHTO T 22. Test each cylinder to failure. Use a compression machine that automatically records the date, time, rate of loading, and maximum load of each cylinder. Include a printout of this information with the compressive strength documentation for each cylinder tested.
- (2) Use these test results to determine opening strength as specified in 415.3.17 of the standard specifications. Alternatively, the contractor may use core or maturity tests to determine opening strength as allowed under 415.3.17.

B.6.3 Air Content

- (1) On each day of production, test the concrete air content as early and as frequently as it is practical until the concrete meets the specifications and the production process is under control.
- (2) Have an HTCP certified PCC technician I or IA test air content according to AASHTO T 152, as modified by the department. The lower and upper specification limits for air content are the values specified in 501.3.2.4.2 of the standard specifications. Document admixture dosage rates, time of day, and air temperature on the ancillary concrete daily test report whenever changing an admixture dosage rate.
- (3) Double the air content test frequency if an individual air test falls outside the following warning bands:
 1. For deck overlay grade E concrete: less than 5.5% or greater than 6.5%.
 2. For slip-formed concrete: less than 6%.
 3. For all other concrete: less than 5%.

Continue testing at increased frequency until an individual test point is back within the warning band.

- (4) If an individual air test is outside the specification limits, notify the engineer, and perform additional air tests as often as it is practical on subsequent loads until the air

content is inside the specification limits. The material is nonconforming when an individual test result exceeds the specification limit. Material from the load with the first test exceeding the specification limit, continuing to but not including the load with the first subsequent test within the specification limits, is nonconforming. The department may direct removal and replacement or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

B.6.4 Concrete Temperature

- (1) Have an HTCP certified PCC technician I or IA measure concrete temperature according to AASHTO T 309. Test concrete taken from the same sample used for air content testing. Record concrete temperatures on the air content control chart.

B.6.5 Slump

- (1) Have an HTCP certified PCC technician I or IA measure slump according to AASHTO T 119. The contractor need not test slump for concrete placed by slip-form methods unless the engineer requests. Provide material conforming to the slumps specified in 501.3.7.1 of the standard specifications.

B.6.6 Aggregate Gradations

- (1) Have an HTCP certified Aggregate Technician I or IPP perform aggregate gradation tests according to AASHTO T 11 and T 27.
- (2) The engineer may accept aggregate gradation based upon satisfactory records of previous testing of the material at the time of aggregate production. Otherwise, test aggregate gradations at the frequency listed below which results in the least number of tests.
 1. A maximum of one test per day.
 2. A minimum of one test per 400 cubic yards of cumulative concrete placed.

C Department Testing

C.1 Verification Testing

- (1) The department will have an appropriately HTCP certified technician perform verification testing. The department will sample randomly at locations independent of the contractor's QC work. In all cases, the department will conduct the verification tests with separate personnel and equipment from the contractor's QC tests. The department will perform verification testing at a frequency of 10 percent of the random concrete quality control tests or a minimum of once per project, or at greater frequency if determined to be necessary by the engineer. Department verification testing is optional for aggregate used in the concrete.
- (2) If verification tests indicate conformance with specifications, no further action is required. If verification tests indicate nonconformance with specifications, the engineer and contractor will jointly investigate any testing discrepancies. The investigation may include additional testing as well as review and observation of both the department's and contractor's sampling and testing procedures and equipment.

Both parties will document all investigative work.

- (3) Correct all deficiencies. If the contractor does not respond to an engineer request to correct a deficiency or resolve a testing discrepancy, the engineer may suspend production until action is taken. Resolve disputes as specified in D.

C.2 Independent Assurance Testing

- (1) Independent assurance is unbiased testing the department performs to evaluate the department's verification and the contractor's QC sampling and testing including personnel qualifications, procedures, and equipment. The department will perform the independent assurance review according to the department's independent assurance program.
- (2) If the department identifies a deficiency, and after further investigation confirms it, correct that deficiency. If the contractor does not correct or fails to cooperate in resolving identified deficiencies, the engineer may suspend production until action is taken. Resolve disputes as specified in D.

D Dispute Resolution

- (1) The engineer and contractor should make every effort to avoid conflict. If a dispute between some aspect of the contractor's and the engineer's testing program does occur, seek a solution mutually agreeable to the project personnel. The department and contractor may review the data, examine data reduction and analysis methods, evaluate sampling and testing procedures, and perform additional testing. Use ASTM E 178 to evaluate potential statistically outlying data.
- (2) If the project personnel can not resolve a dispute and the dispute affects payment or could result in incorporating nonconforming product, the department will use third party testing to resolve the dispute. The department's central office laboratory, or a mutually agreed on independent testing laboratory, will provide this testing. The engineer and contractor will abide by the results of the third party tests. The party in error will pay service charges incurred for testing by an independent laboratory. The department may use third party test results to evaluate the quality of questionable materials and determine the appropriate payment. The department may reject material or otherwise determine the final disposition of nonconforming material as specified in 106.5 of the standard specifications.

E Acceptance

- (1) The department will accept concrete based on the contractor QC tests unless it is shown through the verification, or the dispute resolution process that the contractor's test results are in error.

F Payment

- (1) Costs for all QMP sampling, testing, and documentation required under this special provision are incidental to the work. If the contractor fails to perform the work required under this special provision, the department may reduce the contractor's pay.

The department will administer pay reduction under the Non-performance of QMP administrative item.
(090105) 501-065

16. Wall Modular Block Gravity, Item 532.0200.S.

A Description

- (1) This special provision describes designing, furnishing materials and erecting a permanent earth retention system in accordance with the lines, dimension, elevations and details as shown on the plans and provided in the contract. The design life of the wall and all wall components shall be 75 years.

B Materials

B.1 Proprietary Modular Block Gravity Wall Systems

- (1) The department specifies approved modular block gravity wall products on the department's approved products list.
- (2) Proprietary wall systems may be used for this work, but must conform to the requirements of this specification and be pre-approved for use by the department's Bureau of Structures, Structures Development Section. The name of the companies supplying pre-approved material shall be furnished within 25 days after the award of contract. The department maintains a list of pre-approved systems of retaining walls. To be eligible for use on this project, a system must have been pre-approved and added to that list prior to the bid opening date.
- (3) Applications for pre-approval may be submitted at any time. Applications must be prepared in accordance with the requirements of chapter 14 of the department's Bridge Manual. Information and assistance with the pre-approval process can be obtained by contacting the Structures Development Section in Room 601 of the Hill Farms State Transportation Building in Madison or by calling (608) 266-8494.

B.2 Design Requirements

- (1) It is the responsibility of the contractor to supply a design and supporting documentation as required by this special provision for review by the department to show that the proposed wall design is in compliance with the design specifications. The following shall be submitted to the engineer for review and acceptance no later than 21 days before wall construction will begin.
- (2) The design/shop plans shall be prepared on reproducible sheets 11 inch x 17 inch, including borders. Each sheet shall have a title block in the lower right corner. The title block shall include the project identification number and structure number. Design calculations and notes shall be on 8 1/2 inch x 11 inch sheets, and shall contain the project identification number, name or designation of the wall, date of preparation, initials of designer and checker, and page number at the top of the page. All plans and calculations shall be signed, sealed and dated by a professional engineer licensed in the State of Wisconsin. Four copies of the shop drawings and two copies of the design calculations and supporting materials shall be submitted.

- (3) The design of the Modular Block Gravity Wall shall be in conformance with the latest edition of the AASHTO Standard Specifications for Highway Bridges including interim specifications, the standard specifications, and standard engineering design procedures as determined by the department. The design must include analyses that clearly show the factors of safety for overturning, sliding and soil bearing stress. The width of the modular block from front face to back face of the wall shall be given in the design computations and shown on the wall shop drawings.
- (4) The minimum embedment to the bottom of the modular block shall be 1 foot 6 inches, or as specified in the plan.

B.3 Wall System Components

- (1) Materials furnished under this contract shall conform to the requirements hereinafter provided.

B.3.1 Backfill

- (1) Wall Backfill, Type A, shall comply with the requirements for coarse aggregate No. 1 as given in 501.2.5.4 of the standard specifications. All backfill placed within a zone from the base of the leveling pad to the top of the final layer of wall facing units and within 1 foot behind the back face of the wall shall be Wall Backfill, Type A. This includes all material used to fill openings in the wall facing units.
- (2) A layer of Geotextile Fabric Type “DF” (Schedule B) shall be placed vertically between the retained soil and the Type A backfill. The geotextile fabric shall extend from the top of the leveling pad to 6 inches below the surface of the retained soil. The geotextile shall then wrap across the top of the Type A backfill to the back of block wall facing.

B.3.2 Wall Facing

- (1) Provide wall facing units that consist of precast modular concrete blocks. All units shall incorporate a mechanism or devices that will develop a mechanical connection between vertical block layers. Units that are cracked, chipped or have other imperfections in accordance with ASTM C1372 or excessive efflorescence shall not be used within the wall. A single block type and style shall be used throughout each wall. The color and surface texture of the block shall be as given on the plan, or chosen by the engineer.
- (2) The top course of facing units shall be a solid precast concrete unit designed to be compatible with the remainder of the wall. The finishing course shall be bonded to the underlying facing units with a durable, high strength, flexible adhesive compound compatible with the block material. A formed cast-in-place concrete cap may also be used to finish the wall. A cap of this type shall be designed to have texture, color, and shall have an appearance that complements the remainder of the wall. The vertical dimension of the cap shall not be less than 3 1/2 inches. Expansion joints shall be placed in the cap to correspond with each 24-inch change in vertical wall height or at a maximum spacing of 10 feet. Concrete for all cast-in-place caps shall be Grade A and shall conform to the requirements of 501.3 of the standard specifications.

- (3) Block dimensions may vary no more than $\pm 1/8$ inch from the standard values published by the manufacturer, in accordance with ASTM C1372. Blocks must have a minimum depth (front face to back face) of 8 inches. The minimum front face thickness of blocks shall be 4 inches measured perpendicular from the front face to inside voids greater than 4 square inches. Also the minimum allowed thickness of any other portion of the block is 2 inches. The front face of the blocks shall conform to plan requirements for color, texture, or patterns.
- (4) Cementitious materials and aggregates for modular blocks shall conform to the requirements of ASTM C1372 Section 4.1 and 4.2. Modular blocks shall meet the following requirements.

Test	Method	Requirement
Compressive Strength (psi)	ASTM C140	5000 min.
Water Absorption (%)	ASTM C140	6 max.
Freeze-Thaw Loss (%) 40 cycles, 5 of 5 samples 50 cycles, 4 of 5 samples	ASTM C1262 ⁽¹⁾	1.0 max. ⁽²⁾ 1.5 max. ⁽²⁾

⁽¹⁾ Test shall be run using a 3% saline solution.

⁽²⁾ Test results that meet either of the listed requirements for Freeze-Thaw Loss are acceptable.

- (5) All blocks shall be certified as to strength, absorption, and freeze-thaw requirements unless, due to contract changes, certified blocks are not available when required. At the time of delivery of the certified blocks, furnish the engineer a certified test report from a department-approved independent testing laboratory for each lot of modular blocks. The certified test report shall clearly identify the firm conducting the sampling and testing, the type of block, the date sampled, name of the person who conducted the sampling, the represented lot, the number of blocks in the lot, and the specific test results for each of the stated requirements of this specification. A lot shall not exceed 5000 blocks. The certified test results will represent all blocks within the lot. Each pallet of blocks delivered shall bear lot identification information. Block lots that do not meet the requirements of this specification or blocks without supporting certified test reports will be rejected and shall be removed from the project at the contractor's expense.
- (6) A department-approved independent testing laboratory shall control and conduct all modular block sampling and testing for certification. Prior to sampling, the manufacturer's representative shall identify all pallets of modular blocks contained in each lot. All pallets of blocks within the lot shall be numbered and marked to facilitate random sample selection. The representative of the independent testing laboratory shall identify five pallets of blocks by random numbers and shall then select one block from each of these pallets. Solid blocks used as a finishing or top course shall not be

selected. The selected blocks shall remain under the control of the person who conducted the sampling until shipped or delivered to the testing laboratory. All pallets of blocks within a lot shall be strapped or wrapped to secure the contents and tagged or marked for identification. The engineer will reject any pallet of blocks delivered to the project without intact security measures. The contractor shall remove all rejected blocks from the project at no expense to the department.

- (7) The department may conduct testing of certified or non-certified modular blocks lots delivered to the project. The department will not do freeze-thaw testing on blocks less than 45 days old. If a random sample of 5 blocks of any lot tested by the department fails to meet any of the requirements of this specification (nonconforming), the contractor shall remove from the project site all blocks from the failed lot not installed in the finished work at no cost to the department, unless the engineer allows otherwise. Nonconforming blocks installed in the finished work will be considered approved by the department as stated in subsection 106.5(2) of the standard specifications and any adjustment to the contract price will not exceed the price of the blocks charged by the supplier.

B.3.3 Leveling Pad

- (1) For all walls over 5 feet tall measured from the top of the leveling pad to the top of the wall, the wall leveling pad shall consist of a poured concrete masonry pad made from Grade A concrete as specified in section 501 of the standard specifications. The depth of the leveling pad shall be as shown on the plans or 6-inches minimum. The leveling pad shall be as wide as the blocks plus 6-inches. Six inches of leveling pad shall extend beyond the front face of the blocks. The bottom of the blocks shall be horizontal and 100% of the block surface shall bear on the leveling pad. A concrete leveling pad shall be used for the entire length of the wall. All walls with a Structure Number assigned (such as R-XX-XXX) shall be built using the concrete leveling pad given above. The leveling pad shall step to follow the general slope of the ground line. The leveling pads steps shall keep the bottom of the wall within one block's thickness of the minimum embedment, i.e. minimum embedment plus up to the thickness of one block. Additional embedment may be detailed but will not be measured for payment.
- (2) On walls less than or equal to 5 feet in height without a wall number assigned, a compacted leveling pad made from base aggregate dense 1 1/4 inch as given in section 305 of the standard specifications may be used. The depth of the aggregate leveling pad shall be as shown on the plans or 12-inches minimum. The aggregate leveling pad shall be as wide as the blocks plus 12 inches with 12 inches of pad extending beyond the front face of the wall.

C Construction

- (1) Construct the modular block gravity wall in accordance with the manufacturer's instructions at the locations and to the dimensions shown on the plan and as directed by the engineer. At the end of each working day, provide good temporary drainage such that the backfill shall not become contaminated with run-off soil or water if it should rain. Do not stockpile or store materials or large equipment within 10 feet of the front face of the wall.
- (2) Place materials in the areas as indicated on the plans and as detailed in this specification. Backfill lifts shall be no more than 8-inches in depth. Backfilling shall closely follow erection of each course of wall facing units.
- (3) Compact each layer of wall backfill Type A with at least three passes of lightweight manually operated compaction equipment acceptable to the engineer.
- (4) Conduct backfilling operations in such a manner as to prevent damage or misalignment of the wall facing units. At no expense to the department, correct any such damage or misalignment as directed by the engineer.
- (5) Do not operate tracked or wheeled equipment within 3 feet of the back face of the blocks. The engineer may order the removal of any large or heavy equipment that may cause damage or misalignment of the wall facing units.
- (6) After construction of the wall, restore the surrounding area located above and below all precast block retaining wall sites to its original condition and to the finished details on the plans.

D Geotechnical Information

- (1) Geotechnical data to be used in the design of the wall is given on the wall plan. The allowable soil bearing capacity is given on the plan. After completion of excavation, the department's District Soils Engineer will inspect the site and will determine if the foundation is adequate for the intended loads. Allow the District Soils Engineer two working days to perform the inspection.

E Measurement

- (1) The department will measure Wall Modular Block Gravity in area by the square foot of face on a vertical plane between the top of the leveling pad and a line indicating the top of wall including wall cap or copings as required and shown on the plans. Unless directed by the engineer, wall area constructed above or below these limits will not be measured for payment.

F Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
532.0200.S	Wall Modular Block Gravity	SF

- (2) Payment is full compensation for supplying a design and shop drawings; preparing the site, including all necessary excavation and disposal of surplus materials; supplying all necessary wall components to produce a functional system including cap and copings; constructing the retaining system; providing backfill, backfilling, and compacting the backfill; furnishing and installing geotextile fabric; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the contract work. Parapets, railings, and other items above the wall cap or coping will be paid for separately.
- (3) Any required topsoil, fertilizer, seeding or sodding and mulch will be paid for at the contract unit price of topsoil, fertilizer, seeding or sodding and mulch, respectively.
(082004) 532-030

17. Furnishing and Planting Plant Materials.

Amend section 632 of the standard specifications with the following:

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes the following:
1. Trees
 2. Shrubs
 3. Perennials
 4. Topsoil and soil amendments
 5. Mineral and organic mulches
 6. Edging

1.3 QUALITY ASSURANCE

- A. Landscape work shall be done by a single firm specializing in landscape work.
- B. Source Quality Control:
1. **Do not make substitutions.** If specified landscape material is not obtainable, submit proof of non-availability to Supervising Professional, together with proposal for use of equivalent material.

- C. **Trees, Shrubs and Plants:** Provide freshly dug trees and shrubs. Do not prune prior to delivery unless otherwise approved by engineer. Do not bend or bind-tie in such manner as to damage bark, break branches, or destroy natural shape. Handle balled and burlapped stock by the root ball only. Do not drop balled and burlapped stock during delivery. Do not plant a balled and burlapped plant if the ball is cracked or broken, unless approved by the engineer.
1. Spray anti-desiccant on deciduous trees and shrubs just prior to transport.
 2. Provide protective covering during delivery.
 3. Deliver trees, shrubs, and plants after preparations for planting have been completed and plant immediately. In healing in, open all bundles and separate the plants before the roots are covered; take care so that no air pockets remain among the roots.
 4. Do not remove container-grown stock from containers until planting time.
 5. If planting is delayed more than 6 hours after delivery, set plants in shade, protect from weather and mechanical damage, and keep roots moist with mulch covering, burlap or other acceptable means of retaining moisture.
 6. Water root systems of trees, shrubs and plants stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.4 PROJECT CONDITIONS

- A. **Existing Conditions:** Contractor shall be held to have visited the site, be familiar with the existing conditions and made due allowance for them in a proposal.
- B. **Utilities:** Determine location of underground utilities and perform work in a manner, which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.
- C. **Detrimental Conditions:** When conditions detrimental to plant, seed, or sod growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the engineer before attempting to plant.

1.5 SEQUENCING AND SCHEDULING

- A. Plant or install materials during normal planting seasons for each type of material required or as approved by engineer.
- B. Correlate planting with specified maintenance periods to provide maintenance from date of substantial completion.

- C. Plant shrubs after final grades are established and prior to seeding or sodding unless otherwise acceptable to the engineer. If planting of shrubs occurs after seeding or sodding, contractor shall be responsible for protection of these areas and for promptly repairing any damage caused by planting operations.

PART 2 - PRODUCTS

2.1 FURNISHING AND PLANTING PLANT MATERIALS.

The work under this item shall be in accordance with the plans, sections 632 of the standard specifications and as hereinafter provided.

A. Materials.

1. Plant Materials. All plants shall be grown within the State of Wisconsin, Iowa, or Illinois located within zone 4 or 5 of the United States Department of Agriculture Plant Hardiness Zone Map”, most recent revision, unless otherwise approved by the engineer.

A list of sources for plants shall be furnished in accordance with subsection 632.2.2.8 before planting begins for fall planted plants and before March 15, of the following year for spring planted plants. All sources will be subject to verification by the engineer.

2. Fertilizer for Plant Holes. The first paragraph of subsection 632.2.4.2 shall be amended to require the amount of fertilizer in each packet be a minimum of 2 ounces with a slow-time release period of 3 years.
3. Mineral Mulch: Red granite chips. Crushed Red Granite Chips, size range 1-1/2" maximum, 3/4" minimum and natural central Wisconsin granite red color range.
4. Rodent Protection. Rodent protection for tall-growing trees shall be a minimum 4-foot long double layer of commercial screening wire mesh sheet acceptable to the engineer and installed as shown on the Planting Detail Sheet and described in these special provisions.
5. Polyethylene Edging at stone mulch areas only: Valley View Black Edge-Knight, Patrician SEV, Oly-Ola Edg-King, edging or equivalent. Height 5-inches, straight top, with manufacturer's standard stakes.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS.

- #### **A. Plant Bed Preparation.**
- Planting Layout: Subsection 632.3.3 shall be amended as follows: Contractor shall lay out individual tree and shrub locations for multiple plantings by lath staking or flagging. Secure engineer's approval before planting. Make minor adjustments as may be required.

- B. Excavation of Plant Holes. Subsection 632.3.4 is revised as follows: The minimum horizontal measurement of the plant hole shall not be less than 24 inches (600 mm) greater than the diameter of the mass for the full depth of the planting hole. Excavation of plant holes to be accomplished by hand methods.
- C. Do not disturb the bottom of the planting hole. The bottom of the rootball shall be in direct contact with the bottom of the hole. Do not add extra fill to the bottom of the hole.
- D. Pruning. Subsection 632.3.5 shall be supplemented with the following: Prune in accordance with American National Standards Institute publication ANSI A300-1995, "Tree, Shrub and Other Woody Plant Maintenance – Standard Practices". Prune in accordance with subsection 632.3.5 with the following exceptions: "Flush with the trunk or branch" is clarified to mean that the bark ridge and branch collar shall be left intact, and the pruning cut shall be made immediately above the bark ridge and branch collar
- E. Planting. Planting shall follow the procedure contained in subsections 632.3.7 through 632.3.17. Except subsection 632.3.7 shall be amended as follows: Tree and shrub plant holes shall be backfilled with a three-to-one (3:1) mixture of topsoil to peat humus compost. Soil shall also be amended to maintain a pH level of between 6.5 and 7.4.
- F. Red granite chips bedding. Place granite material in the area around the individual plants and within the entire area indicated as "planting bed limits" on the landscaping details within 5 days of the second watering required under planting. Areas to be mulched shall be free of living weeds and grasses before mulch is applied.
- G. Rodent Protection. Apply rodent protection to those plants indicated on the Plant Data Chart of the plan in accordance with subsection 632.3.13. Place the rodent protection material around each tree trunk with the bottom of the material resting on the soil surface and the top a minimum of 48 inches above the surrounding earth surface, or to the lowest branches of small trees. Wrap the rodent protector loosely around the tree trunk and staple it to itself at maximum 6-inch intervals along the seam.

3.2 PLANT ESTABLISHMENT AND REPLACEMENT.

- A. Plant Establishment Period. A two-year plant establishment period is required in accordance with subsection 632.3.19.1.

18. Traffic Control.

The work under this item shall be in accordance with the requirements of section 643 of the standard specifications, as shown on the plans or as approved by the engineer, and as hereinafter modified.

Have available at all times sufficient experienced personnel to promptly install, remove and reinstall the required traffic control devices to route traffic in order to perform construction operations.

During the life of this contract, provide 24-hour-a-day availability of equipment and forces to promptly restore barricades, lights, or other traffic control devices that are damaged or disturbed. In no case shall any barricade, light, or other traffic control device be out of service for more than two hours. The cost to maintain and restore the above items shall be considered incidental to the item of Traffic Control and no additional payment will be made therefore.

Mask-out all traffic control signs when not in use.

The traffic requirements are subject to change at the direction of the engineer in the event of an emergency.

19. Traffic Control Covering Signs, Item 643.0905.S.

A General

This special provision describes covering sign messages, maintaining the sign covering, and removing the sign covering, as shown on the plan and as hereinafter provided. The covered sign message shall be unreadable during daytime and nighttime hours.

B Materials

Provide covering material of sufficient durability to withstand the effects of weather. Provide porous cloth or sheet aluminum covering. If porous cloth covers are provided, only provide those that do not allow light to reflect from the sign face at night.

Tape, paper, plastic, or sheet metal covers will not be allowed.

C Construction

If porous cloth covering is provided, fold porous cloth covers over the sign edges and secure to the back of the sign. When only a portion of the sign is to be covered, cover only the area of the sign designated to be covered with the cloth cover held tightly in place using a rope system or other system as approved by the engineer. Secure the cloth so that it will not flap against the sign face.

If sheet aluminum covers are provided, rivet the covering to the sign face. Provide rivets that are a maximum of 3/16-inch in diameter. When only a portion of the sign is to be covered, provide aluminum cover sheeting that has on its face the same color as the surrounding sign.

D Measurement

The department will measure Traffic Control Covering Signs in units for each sign covered. Multiple covers on the same sign will be paid for separately. Multiple coverings and removals of sign coverings on the same sign will be paid for separately.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
643.0905.S	Traffic Control Covering Signs	Each

Payment is full compensation for furnishing, installing, maintaining, and removing sign covers; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the contract work.

(050205) 643-040

20. Traffic Control Signs Portable Changeable Message, Item 643.1050.S.

A Description

- (1) This special provision describes furnishing, maintaining and installing portable changeable message signs as hereinafter provided.

B Materials

- (1) Furnish equipment that enables one person to transport and operate the sign easily without assistance.
- (2) Provide a complete Changeable Message Sign and trailer that is painted highway safety orange, except the sign case, which shall be painted black.

B.1 Sign Case

- (1) Provide a sign that is capable of displaying a minimum of three (3) lines of message text per message (frame). Each line shall consist of a minimum of eight (8) characters, equally spaced a minimum of three inches (3") and a maximum of four and one-half inches (4½") apart. Characters shall be a minimum of seventeen inches (17") high and a minimum of eleven inches (11") wide and be legible from a minimum of 850 feet during both day and night conditions. The maximum sign width shall be eleven feet six inches (11'-6"). Provide a sign display that consists of either a continuous matrix of pixels or individual character modules consisting of smaller matrices of pixels. Each matrix forming a character shall consist of a minimum thirty-five (35) pixels in a five (5) horizontal pixel by seven (7) vertical pixel arrangement. Each pixel shall consist of a high-intensity LED cluster. The LED lamps shall run at a minimum voltage to provide extended life. Each pixel shall be either square in shape with a minimum of two-inch (2") sides or round in shape with a minimum two-inch (2") diameter. The driver board shall provide means for dimming. The entire sign shall complete a message change within 100 milliseconds.

- (2) The circuit boards used in the sign case shall be constructed of components readily available from at least two other sources. Provide a schematic of the circuit boards.
- (3) Provide a sign housing that is weatherproof and is constructed of aluminum. The front face shall be covered with either a one-piece, clear, non-glare, lexan panel, or individual one-piece, clear, non-glare, lexan panels.

B.2 Raise and Lower Mechanism

- (1) Provide a sign that has a vertical mast assembly constructed of structural steel tubing. The sign shall include a built-in electric powered hydraulic pump capable of fully raising the sign within one minute. Provide signs that are equipped with a manual lifting device, which can be readily accessed. Provide signs that are designed to rise to variable heights between its cradle and its full height; however, the bottom of the sign shall always be able to rise to a minimum height of seven feet zero inches (7'-0") above the ground, and capable of being locked at various heights. Provide a means to prevent tampering with the sign while raised to any locked height. The sign shall be capable of rotating 360 degrees atop the raise and lower mechanism (mast) while raised to any locked height. The mast assembly shall have a mechanism for locking the sign in place when it is extended. When extended, the sign shall be able to be locked at any display angle. Provide means to prevent tampering with the display angle once it is locked.

B.3 Controller

- (1) Provide a programmable microprocessor (controller) that shall direct and control all sign operations. Provide a controller that is furnished with a full size 101 key keyboard, which contains standard alphanumeric keys. The keyboard shall be capable of being used for operation of the controller in creating, storing and displaying additional sign messages. The controller shall be capable of storing a minimum of 200 messages (frames). The sign shall be capable of displaying from one (1) to six (6) messages in sequence. The manufacturer of the sign shall preprogram and install a minimum of 150 messages. In addition, provide a controller that:
 1. Has the capacity for storage, recall and display of a minimum of 50 operator created messages.
 2. Is able to recall from memory, preview, and display message sequences at least six frames long.
 3. Is capable of storing a minimum of 25 message sequences, which can be created by the operator using any combination of preprogrammed messages and user created messages.
 4. Allows the operator to vary the message flash rate and sequence rate in 1/4-second intervals or less with the flash rate extending from zero (0) seconds to at least four (4) seconds.
 5. Allows the operator to generate a moving or flashing arrow symbol, which is

capable of being displayed on any line of a message while text is displayed on other lines of the message.

6. Allows the operator to generate a larger moving or flashing arrow symbol, which is capable of being displayed on the entire sign face, using all three lines. Either of these message frames containing arrow symbols shall be capable of being included in a sequence.
 7. Allows the operator to flash (blink) selected lines of messages and include these messages within a message sequence.
 8. Is equipped with a display screen for previewing the actual sign message prior to display on the sign.
 9. Is removable for ease of replacement, service, or programming.
- (2) Program each controller with a password system that will deter unauthorized programming of the controller. The password system shall include at least two levels of security such that operators at one level may only change message sequences displayed using preprogrammed sequences and operators at a higher level may create and store messages or message sequences. Operators at the higher level shall also be capable of displaying message sequences.
 - (3) When the sign is not in operation, a back up battery shall supply power to the controller.
 - (4) Provide ambient light controlled continuous dimming, with a minimum range of one-hundred percent (100%) to forty percent (40%) for the sign display. Provide a means for manually controlled dimming.
 - (5) Provide a control panel that has switches for raising and lowering the sign. Provide a night light for the control panel and controller screen and install it in the controller console cabinet.
 - (6) Provide a Changeable Message Sign that is fully equipped to receive commands to change standard messages and to allow monitoring of sign operations through a cellular telephone connection at the sign unit, without rewiring the cabinet connections. Provide a modem, which operates at a minimum speed of 2400 BAUD. The controller shall be capable of receiving commands via cellular telephone from a personal computer based remote station; furnished with a standard RS-232 interface such that a laptop PC may be connected with the controller to exchange data; and shall also be equipped to connect to a standard telephone land line for remote control operation.

- (7) The command protocol with which the controller communicates externally shall be of a standard format and be capable of being reconfigured. The command protocol with which the controller communicates via an RS-232 interface shall be a standard format and be capable of being reconfigured.
- (8) The manufacturer shall provide and install a cellular phone unit.
- (9) The circuit boards used in the controller shall be constructed of components readily available from at least three other sources. Provide a schematic of the circuit boards.
- (10) Provide surge protection for all electronic components.

B.4 Power Source

- (1) Provide a solar Changeable Message Sign that runs on a battery system using a solar charging system. The solar-powered battery charging system shall consist of an array of high-efficiency, single-crystal silicon cells mounted on top of the sign panel and a voltage regulator to prevent overcharging of the battery system. The system shall use deep-cycle batteries and shall include a voltage meter and ammeter.
- (2) Provide solar cells that are capable of charging and maintaining the batteries at operational levels under all weather conditions experienced in Wisconsin. The solar array panel shall be capable of rotating 360 degrees atop the sign case and shall be capable of being locked in any position. The solar array panel shall either be tilted at an angle of 45 degrees relative to the horizon or shall be capable of tilting from 0 degrees to a minimum of 45 degrees and shall be capable of being locked in any position. A switch shall be provided to disconnect the solar power supply for safety during maintenance.
- (3) The batteries shall be housed in a waterproof, heavy-duty housing which is equipped with necessary hardware to be locked using a padlock or build in lock. The batteries shall be of a standard size and type and be available from at least three different manufacturers. The housing that contains the batteries shall be capable of accommodating batteries from at least three different manufacturers. The batteries shall provide adequate back up power for the Changeable Message Sign to operate at full operation for 20 days having ambient air temperatures of 20 degrees Fahrenheit without any sun exposure to the solar array. Certification of the sign's ability to operate for a period of 20 days without exposure to sunlight, as stated above, shall be provided by an independent laboratory. Supply a switch to disconnect the battery supply for safety during maintenance.
- (4) Provide a sign that is equipped to receive and use external 110-volt alternating current as an alternate source of power.

- (5) Provide a sign that is equipped with a charging device that operates on 110-volt alternating current and is capable of charging the deep-cycle battery system within 24 hours. The charging device shall automatically shut off when battery system is fully charged to prevent overcharging.
- (6) Equip the entire unit with an isolated ground circuit. Connect the ground wires to an isolated terminal block. The frame of the trailer shall not be a part of the ground system, except possibly for the alternating current charging and operating systems.
- (7) Provide external wiring that is of single length; has no splices; and is protected from weather and obstructions that may be encountered during transport.
- (8) Protect all break lines from obstructions encountered during transport.

B.5 Trailer

- (1) Provide a highway trailer that has a maximum width of eight feet six inches (8'-6"); is constructed of heavy-gauge, rectangular structural steel tubing; and is equipped with either screw-type or hydraulic leveling jacks, trailer tongue jack with wheel, fenders, surge brakes, trailer hitch coupling with safety chains, and a rear bumper. In addition, the trailer shall meet the following requirements:
 - 1. Have a straight axle and two fifteen-inch (15") wheels and tires with a combined rated load capacity greater than the weight of the entire sign unit and trailer.
 - 2. Equipped with standard highway brake lights, turn signals, and hazard lights and shall be wired into a round, six-prong connector. All wires shall be single length with no splices.
 - 3. Enclose the battery system and the controller console in separate rustproof metal cabinets. The cabinets shall be equipped with the necessary hardware to be locked using a padlock or built in lock. Exterior metal surfaces shall be painted federal orange. The doors and lids to the cabinets shall be equipped to be locked in the open position to prevent accidental closure.
 - 4. Have a 6000-pound capacity surge brake actuator.
 - 5. The trailer fenders shall be a heavy-duty, walk-on type.
 - 6. The trailer shall be provided with a walk-on deck, a minimum of 18 inches in width, along both sides of the sign case. Install the decks so that they are in front of and adjacent to both sides of the sign case when the sign case is locked in the transport mode. The walk-on decks shall be the same length as the trailer. Provide non-slip treads on these decks and on all trailer locations where service or maintenance standing or climbing will be required.

- (2) Provide a trailer hitch coupling that is Class III with a minimum capacity of 5,000 pounds and provides for hookup to a two-inch (2") ball type hitch. The coupling shall be capable of being tightened to the ball type hitch by hand turning a wheel. Provide heavy-duty safety chains with safety type hooks and attached them to the trailer for use with the coupling and hitch assembly.
- (3) Equip the trailer with a means of preventing theft of the trailer.
- (4) Provide the trailer with at least four leveling jacks (described above), which will level the trailer on a 6:1 slope and support 5000 pounds each. The leveling jacks shall be connected to extendable outriggers. The outriggers shall be capable of extending a minimum of twenty-four inches (24") beyond the frame of the trailer. The outriggers shall be capable of being locked in at least the following three positions:
 1. Flush with the frame of the trailer.
 2. Extended twelve inches (12") beyond the trailer frame.
 3. Extended twenty-four inches (24") beyond the trailer frame.
- (5) The leveling jacks shall be capable of being stowed when not in use such that they do not protrude beneath the frame of the trailer. The trailer and sign shall be capable of withstanding wind gusts of up to 80 miles per hour when in operation with sign raised to maximum height and leveling jacks extended. The trailer shall also be equipped with a tongue jack that has a wheel. The tongue jack shall have a capacity greater than the tongue weight of the trailer.
- (6) Provide a trailer that is capable of mounting or descending six inch (6") curbs without the frame striking the curb.
- (7) Provide a trailer that is legal for use on Wisconsin roads in accordance with State of Wisconsin statutes.

C Construction

- (1) Install portable changeable message signs level at the locations to be determined by the engineer.
- (2) On the day the signs are to become operational, have a representative familiar with the operation and repair of the signs available at the project site. The representative shall remain available until all signs are operating satisfactorily.

D Measurement

- (1) The department will measure Traffic Control Signs Portable Changeable Message per each unit complete per day.
- (2) Any day in which the changeable message boards are not working properly for more than six hours will result in one day being deducted from the quantity measured for payment, plus an additional \$100 that the contractor will be liable to the department.

E Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
643.1050.S	Traffic Control Signs Portable Changeable Message	Day

- (2) Payment is full compensation for furnishing, maintaining and installing the complete unit; and for furnishing all labor, tools, equipment, services and incidentals necessary to complete the contract work.

(090105) 643-050

21. Benches, Item SPV.0060.01.**A Description**

This special provision describes furnishing and installing benches as shown on the plans or as designated by the engineer.

B Materials

Benches shall be Model 88-60-PL/S3: 6-foot bench, Gull Wing (surface-mount) supports, Cedar Poly (recycled plastic) slats, black powder coat finish framework as manufactured by DuMor, Inc. Mifflintown, PA, or an equivalent product provided by one of the following manufacturers:

1. Victor Stanley, Inc. Dunkirk, MD (model S-13)
2. Landscape Forms, Inc. Kalamazoo, MI (model Balustrade)

C Construction

Install in accordance to the manufacturer's recommendations and anchor with removable-sleeved concrete expansion anchors per manufacturer's recommendations.

D Measurement

The department will measure Benches by the unit and the quantity measured for payment shall be the number of units of each complete in place and accepted.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.01	Benches	Each

Payment is full compensation for furnishing, and installing the benches; and for furnishing all labor, equipment, tools, and incidentals necessary to complete the work.

22. Flag Poles, Item SPV.0060.02.

A Description

This special provision describes furnishing and installing Flag Poles in accordance with the standard specifications, as shown on the plans, the pertinent provisions of the article SWEF Building, General Construction, and as hereinafter provided.

A.1 Related Documents

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

A.2 Summary

A. This section includes the following:

1. Aluminum flagpoles.

B. Related sections in the article SWEF Building, General Construction include the following:

1. Division 3 Section "Cast-in-Place Concrete" for concrete footings for flagpoles, if any, and if not specified in this Section.
2. Division 7 Section "Joint Sealants" for elastomeric sealant filling the top of the foundation tube, if any.

A.3 Performance Requirements

A. Structural Performance: Provide flagpoles capable of withstanding the effects of wind loads as determined according to the building code in effect for this Project or NAAMM FP 1001, "Guide Specifications for Design Loads of Metal Flagpoles," whichever is more stringent.

1. Base flagpole design on maximum standard-size flag suitable for use with pole or flag size indicated, whichever is more stringent.
Select 1 of 5 below or modify. Verify with project's structural designer.

2. Flagpole to fly 2-4" x 6' flags.

A.4 Submittals

A. Product Data: For each type of flagpole required. Include installation instructions.

B. Shop Drawings: Show general layout, jointing, grounding method, and anchoring and supporting systems. Include details of foundation system for ground-set poles.

C. Structural Calculations: For flagpoles indicated to comply with certain design loadings, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Finish Samples for Verification: For each finished metal used for flagpoles and accessories.

A.5 Quality Assurance

A. Source Limitations: Obtain each flagpole as a complete unit from a single manufacturer, including fittings, accessories, bases, and anchorage devices.

A.6 Delivery, Storage and Handling

A. General: Spiral wrap flagpoles with heavy kraft paper or other weather tight wrapping and enclose in a hard fiber tube or other protective container.

B Materials

B.1 Manufacturers

B.1.1 Available Manufacturers

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

B.1.2 Manufacturers

Subject to compliance with requirements, provide products by one of the following:

1. Baartol Co., Inc.
2. Concord Industries, Inc.
3. Eder Flag Manufacturing Co., Inc.
4. Ewing: John Ewing & Co. Inc.
5. ICC Manufacturing Co.; Morgan-Francis Div.; AABEC Pole Div.
6. Kearney-National Inc.; American Flagpole Div.
7. Lingo, Inc.; Acme Flagpole Co. Div.
8. Michigan Flagpole Inc.
9. Olympus Flag & Banner; EMC Div.
10. PLP Composite Technologies, Inc.
11. Pole-Tech Co., Inc.
12. American Flagpole

B.2 Flag Poles

B.2.1 Pole Construction, General

Construct poles and ship to Project site in one piece, if possible. If more than one piece is necessary, provide snug-fitting precision joints with self-aligning, internal splicing sleeve arrangement for weather tight, hairline field joints.

B.2.2 Aluminum Flagpoles

Fabricate from seamless, extruded tubing complying with ASTM B 241 (ASTM B 241M), alloy 6063, with a minimum wall thickness of 3/16 inch (4.8 mm). Heat treat after fabrication to comply with ASTM B 597, temper T6.

Provide one cone-tapered aluminum flagpole, height 35-feet.

Select above or below. See Evaluations.

B.2.3 Foundation Tube

Galvanized corrugated-steel foundation tube, 0.0635-inch (1.6-mm) minimum wall

thickness, sized to suit flagpole and installation. Provide with 3/16-inch (4.8-mm) steel bottom plate and support plate; 3/4-inch- (19-mm) diameter, steel ground spike; and steel centering wedges all welded together. Galvanize steel parts, including foundation tube, after assembly. Provide loose hardwood wedges at top of foundation tube for plumbing pole.

B.3 Fittings

B.3.1 Finial Ball

Manufacturer's standard flush-seam ball, sized as indicated or, if not indicated, to match pole-butt diameter.

0.063-inch (1.6-mm) spun aluminum with gold anodized finish.

B.3.2 Internal Halyard, Winch System

Manually operated winch with control stop device and removable handle, stainless-steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Provide flush access door secured with cylinder lock. Finish truck assembly to match flagpole.

B.3.3 Halyard Flag Snaps

Provide required stainless steel swivel snap hooks to fly 2 flags on a single pole.

B.4 Miscellaneous Materials

B.4.1 Concrete

Comply with requirements of Division 3 Section "Cast-in-Place Concrete."

B.4.2 Concrete

Provide concrete composed of Portland cement, coarse and fine aggregate, and water mixed in proportions to attain a 28-day compressive strength of not less than 3000 psi (20 MPa), complying with ASTM C 94.

B.4.3 Nonshrink, Nonmetallic Grout

Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

B.4.4 Sand

ASTM C 33, fine aggregate.

B.4.5 Elastomeric Sealant

Comply with requirements of Division 7 Section "Joint Sealants."

B.5 Finishes

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

Aluminum: Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.

Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax for pole.

B.6 Flags

Furnish one USA flag and one Wisconsin state flag. Flags shall be nylon with color-matched thread. Flags shall be constructed with canvas heading and heavy-duty brass grommets. USA flag shall be rectangular and 4-foot tall x 6-foot wide in dimension. Wisconsin state flag shall be rectangular and 3-foot tall x 5-foot wide in dimension.

C Construction

C.1 Concrete Base

Prepare in-ground flagpoles by painting below-grade portions with a heavy coat of bituminous paint.

Excavation: For foundation, excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete.

Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure forms, foundation tube, fiberglass sleeve, or anchor bolts in position, braced to prevent displacement during concreting.

Place concrete immediately after mixing. Compact concrete in place by using vibrators. Moist-cure exposed concrete for not less than 7 days or use a non-staining curing compound.

Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to base perimeter.

C.2 Flag Pole Installation

C.2.1 General

Install flagpoles where shown and according to shop drawings and manufacturer's written instructions.

C.2.2 Foundation-Tube Installation

Install flagpole in foundation tube, seated on bottom plate between steel centering wedges. Plumb flagpole and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch (50-mm) layer of elastomeric sealant and cover with flashing collar.

D Measurement

The department will measure Flag Poles by the individual unit complete in place and accepted.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.02	Flag Poles	Each

Payment is full compensation for furnishing all materials and equipment; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

23. Flood Light, 175-Watt MH With Mounting, Item SPV.0060.03.**A Description**

This special provision describes furnishing and installing a metal halide floodlight, along with the concrete mounting base, electrical pedestal, and flexible conduit connections; and all parts and fittings.

B Materials

The concrete masonry shall conform to concrete masonry for concrete light pole bases, except that it shall be monolithic, not reinforced. The electrical pedestal shall be UL listed for 600 vac. The conduit connection between the pedestal and luminaire shall be liquid tight nonmetallic conduit with listed fittings. Furnish a 5-amp Type "FNQ" fuse, with a fuse holder conforming to fuse assemblies for light poles in this contract.

The luminaire shall be: General Electric P54S 17 M0A1 7x6 DB; Cooper SFS 17MWW76; Holophane PD 175 MHMT; or equal, with polycarbonate vandal shield LVS-P15, or equal.

C Construction

Conform to applicable requirements for concrete light pole bases and for luminaires in this contract. Wiring connections and fusing shall conform to light pole handhole wiring, except that a grounding electrode conductor will not be required.

D Measurement

The department will measure Flood Light, 175-Watt MH With Mounting by the unit, where the unit includes luminaire, lamp, electrical pedestal, flexible conduit, and concrete base, for a complete and operable system.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.03	Flood Light, 175-Watt MH With Mounting	Each

Payment is full compensation for furnishing and installing monolithic concrete masonry, electrical pedestal, luminaire, lamp, electrical pedestal, flexible conduit and concrete base; for furnishing and installing all parts and fittings; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work

24. Trash Receptacles, Item SPV.0060.04.

A Description

This special provision describes furnishing and installing trash receptacles, complete and in place, at the locations as designated on the plans or as directed by the engineer.

B Materials

Trash receptacles shall be steel reinforced concrete with a smooth, weatherstone finish and sand color. Trash receptacles shall be of 53-gallon capacity and shall have a plastic cover with flip type opening. Furnish five sets of catalogue cut and manufacturer's shop drawings to the engineer for approval before ordering.

Acceptable manufacturers are listed below.

1. Pre-Terra Products, P.O. Box 1520, Wausau, WI 54402-1520, (800) 388-8728;
2. Environmental Features, Inc.; and
3. Quick Crete Products.

C Construction

Install trash receptacles in locations indicated on the plans or as directed by the engineer.

D Measurement

The department will measure Trash Receptacles, completed and accepted, by the unit in place.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.04	Trash Receptacles	Each

Payment is full compensation for furnishing, hauling and installing trash receptacles; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work in accordance with the contract.

25. Perennials: Goldstrum Black-Eyed Susan, #2 Cont, Item SPV.0060.05.

A Description

This special provision describes furnishing and planting perennials as shown on the plans in accordance with section 632 of the standard specifications and as hereinafter provided.

B Materials

Materials shall conform to the requirements of section 632 of the standard specifications and these specifications.

C Construction

Plant in accordance to the requirements of section 632 of the standard specifications and as supplemented hereinafter.

Supplement subsection 632.3.7 as follows: Place perennials in planting bed backfilled with planting backfill mixture. Backfill holes with excavated planting backfill mixture.

D Measurement

The department will measure Perennials: Goldstrum Black-Eyed Susan, #2 Cont. by the unit, complete in place and accepted.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.05	Perennials: Goldstrum Black-Eyed Susan, #2 Cont	Each

Payment is full compensation for providing plants; storing, handling, planting, and caring for the plants; properly disposing of excess and waste materials; and for furnishing all labor, materials, tools, equipment and incidentals necessary to complete the work.

26. Concrete Curb & Gutter 36-Inch Type A Special, Item SPV.0090.01.**A Description**

This work shall consist of constructing concrete curb and gutter, 36-inch, Type A special in accordance with section 601 of the standard specifications, as shown in the plans and as hereinafter provided.

B (Vacant)**C (Vacant)****D Measurement**

The department will measure Concrete Curb & Gutter 36-inch Type A Special in length by the linear foot along the base of the curb face, completed and accepted.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.01	Concrete Curb & Gutter 36-inch Type A Special	LF

Payment is full compensation for preparing the foundation; furnishing all materials, including concrete masonry expansion joints and reinforcement tie bars; for placing, finishing, protecting, and curing; for sawing of joints; for backfilling and disposal of surplus materials; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

27. Removing Weight Scale and Pit, Item SPV.0105.01.

A Description

Remove and dispose of existing truck weight scale and break down and remove the scale pit in accordance to the pertinent requirements of section 204 of the standard specifications and as hereinafter provided.

B (Vacant)

C Construction

All scale materials shall become the property of the contractor.

D Measurement

The department will measure Removing Weight Scale and Pit as a single complete unit of work.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.01	Removing Weight Scale and Pit	LS

Payment is full compensation for removing and disposing of the existing truck weight scale; breaking down and removing the scale pit; and for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the contract work.

28. Removing Underground LP Tank, Item SPV.0105.02.

A Description

This special provision describes removing underground LP tanks in accordance with the pertinent provisions of section 204 of the standard specifications and as hereinafter provided.

B (Vacant)

C (Vacant)

D Measurement

The department will measure Removing Underground LP Tank as a single complete unit of work.

E Payment

Supplement 204.5 to include the following:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.02	Removing Underground LP Tank	LS

29. Well Construction & Pressure Tanks, Item SPV.0105.03.

A Description

A.1 Scope

The work to be done under this section includes the furnishing of all labor, materials, transportation, tools, supplies, equipment and appurtenances, necessary for the complete and satisfactory construction, developing, testing, disinfection and operation of the proposed well described herein.

The design intention is to develop a well capable of supplying good quality water, free of sand and contaminants, at a rate of at least 55 gallons per minute (gpm).

The Well Driller must contact Adam Hogan and Bob Kaczmerk, Wisconsin DNR, at (608) 275-3226 and (608) 275-3202 prior to starting construction of the well.

A.2 Related Documents

Applicable Provisions of Division 1 govern all work under this section.

A.3 Local Conditions

A.3.1 General

It is the contractor's responsibility to review whatever geologic data and existing well reports he deems appropriate to familiarize himself with aquifer conditions.

DISCLAIMER: The owner and engineer do not guarantee the accuracy of data or information they provide, nor do they represent that the data and information are necessarily indicative of the conditions to be encountered at the proposed site. Neither the information provided nor information contained in the plans and specifications shall relieve the contractor from any responsibility contracted hereunder, from fulfilling any and all terms of the contract, nor to any additional payment except as set forth in the contract.

A.3.2 Water and Electricity

All electric power and water necessary for construction and testing of the well shall be provided by the contractor at no additional cost to the owner. See General Requirements Section for further information.

A.3.3 Well Discharge

Contain water, cuttings and mud discharged from drilling operations and test pumping in temporary settling ponds.

- Design the ponds to minimize erosion and to prevent sediment-laden water from reaching natural watercourses. Upon completion of drilling and test pumping, abandon the ponds. Remove and haul excess mud and sediment to a suitable landfill

and restore the site to its original condition. Fence ponds to prevent entry of animals and people.

- All costs associated with settling ponds, including design, construction, maintenance, abandonment, fencing and site restoration, shall be borne by the contractor.

A.3.4 Pump Engine

If an engine is used for test pumping, equip it with silencers such that surrounding residents are not disturbed.

A.3.5 Boundaries of Work

Confine operations to the well site as indicated on the drawings. No work shall be performed outside this area without the written consent of the owner.

A.4 Competent Workers

Employ only competent workers for the execution of this work and perform all such work under the direct supervision of an experienced well driller licensed in the State of Wisconsin.

B (Vacant)

C Construction

C.1 General

Construction of the well shall meet the requirements of the Wisconsin Administrative Code NR 812, AWWA Standard A 100, and these specifications.

1. The proposed construction of the well is shown on the Well Profile Detail. The depths and lengths of the various holes and casings are approximate only and will be accurately designed by the Engineer during construction. Keep the engineer fully and currently informed of the nature of the formations being encountered while drilling so that the well construction is proper for the conditions encountered.
2. The engineer may change depths and quantities of work during construction.
3. The well may be drilled by either cable tool or rotary drilling methods. Perform the drilling with a first class drilling unit. For rotary drilling, circulation of drilling fluid shall proceed continuously until the well is cased. Rock walls shall be cleaned of all drilling mud prior to development using methods approved by the engineer. No separate payment will be made for this cleaning.
4. If an upper enlarged drill hole is constructed through unconsolidated material above rock, maintain the hole at full diameter with drilling mud circulated by a suitable pump or with a temporary outer casing. When an outer casing is used, it shall be removed after the sealing process. See (3)(a) of NR 812.14 for further requirements.

C.1.1 Materials

All drive pipe, casings and liners to be left in place shall be new black steel prime pipe conforming to AWWA C200-80, or ASTM A53, A106, or API 5L, 5CT, 5D, or ASTM A 589 – Type I, Grade A or B – Type II, Grade A Type III – driven well pipe. Certificates showing conformance shall be submitted to the Engineer before new materials are placed in the well. Pipe shall be free of oil, grease, rust, or other detrimental materials.

1. All joints shall be watertight, outside bevel, continuous butt welds conforming to AWWA C206. All field welds shall be electric. Inner casing shall have a smooth interior with no projecting welds or seams.
2. All pipe to be driven shall have a drive shoe with drawings to be submitted for approval.
3. Guides or centering lugs, shall be placed on all casings to be grouted in place.
4. Wall thicknesses given are the minimum required per Table V of NR 812.17. It is the responsibility of the contractor to decide whether heavier pipe is needed for successful driving and installation. Pipe damaged during driving or installation shall be removed and replaced or a new well started, all at the contractor's expense.

C.1.2 Temporary Outer Casing

If used, place a steel casing with adequate sidewall thickness from the ground surface to the dolomite (limestone) or sandstone formation. Remove it after the sealing process.

C.1.3 6-Inch Casing

Place a 6-inch I.D. steel casing with at least 0.280 inch walls, weight at least 18.97 pounds per foot from 12 inches above the ground surface down to 15 feet below the surface of the dolomite (limestone) or sandstone formation. Grout the 6-inch casing in place before starting the 6-inch hole.

C.1.4 6-Inch Hole

After the grout has been set for a period of at least 72 hours, drill a 6-inch open hole from the bottom of the 6-inch casing to a depth as directed by the engineer, estimated to be approximately at the 250-foot level. If rotary drilling is used, air-drill this open hole.

C.1.5 Drilling Mud

Use the minimum feasible amount of mud, bentonite, or other drilling aids. Use of such material is subject to the engineer's approval. The purpose of this limitation is to minimize binding of the pores in the rock formation. No drilling mud shall be allowed in the open hole portion of the well.

C.1.6 Clean Well Required

Upon completion, leave the well free from tools, equipment, timber, debris or foreign objects of any kind which may be left through drilling operations or in any way at any time previous to acceptance of the well by the owner.

C.2 Grouting

Fill the annular space between the inner casing and the temporary outer casing, if used, or bore hole wall with neat cement grout. Place the grout seal immediately after the inner casing is set in the desired formation. Do not drill the remainder of the well until the grout seal has been placed and allowed to set, e.g., 72 hours, 24 hours if suitable quick setting cement is used. Comply with all requirements of NR 812.20.

The method of grouting shall consist of a grout shoe and grout pump with a back-up grout pump available in case of emergency. Notify the engineer 48 hours prior to beginning the grouting operation so that a representative can be present to observe the placement of the grout seal.

Center the inner casing in the drill hole before grouting; ensure that it is plumb. Use sufficient and adequate centering guides to assure that the casing will remain centered and plumb. With the assistance of the driller, the engineer will test the casing for plumbness before grouting.

Remove all materials used as drilling aids or other foreign material from the annular space. It is required that the driller establish circulation with a thin bentonite mixture, and, if necessary, seal any crevices or open formations prior to initiating the grouting operation.

The neat cement grout mixture shall be cement and water in a ratio not to exceed 6 gallons of water per sack (94 pounds, one cubic foot) of cement. Cement shall be Portland cement, ASTM C150, Type I, or API-10A, Class A.

The grout for sealing the annular space surrounding the inner casing shall be forced from the bottom of the space to be grouted towards the surface under pressure using a pump and a grout shoe. This shall be a continuous operation and shall be entirely placed before the occurrence of initial set.

The casing shall remain full of water or drilling fluid to counteract the pressure from the grout on the outside of the casing during grouting operations until the grout has set.

Allow grout to overflow from the annular opening until such time as the density is the same as that of the grout being placed. Provide satisfactory evidence to the engineer that this condition has been satisfied.

C.3 Quality of Work

The drill hole shall be no smaller than the size specified, circular in bore, vertical and straight. A crooked, slanted or flattened hole will not be accepted.

The driller shall test for for plumbness and alignment in the presence of the engineer. Provide the necessary equipment for the test. Complete the plumb and alignment tests as described in AWWA A-100 Specifications for Deep Wells and NR 812.19. The well shall not pass if 1) the dummy fails to move freely throughout the area being tested; or 2) the well varies from the vertical in excess of one-half of the smallest inside diameter being tested per 100 feet. The well shall allow the free passage of the pump to be permanently installed in the well to the depth of the pump setting plus 25% of that depth. The well shall be rejected if it contains kinks, bends or corkscrews.

The plumb and the rings on the dummy shall be no greater than ½-inch less than the smallest diameter of the portion of the well being tested. The dummy used for the alignment test shall be 40' long with rings located at each end and in the middle.

The driller shall plumb the 6" hole before installing the 6" diameter casing. The casing shall be plumbed after grouting. After drilling to full depth, the well shall be tested for plumbness and alignment to the full depth. The engineer will observe all plumb tests and alignment.

If the well fails to meet the above requirements, the driller shall correct the alignment at his own expense. Should the alignment not be corrected, the owner shall have the right to refuse payment for the well and refuse to accept the well. An unacceptable well shall be abandoned in accordance with NR812.26 requirements at the driller's expense.

C.4 Development

After cleaning the well and before test pumping, fully develop the well by pumping, as described in Section 9.d.2., and in full compliance of with NR 812.22(1).

Complete development shall be interpreted as that point at which the sand content of the pumped water is no longer increasing or decreasing. A maximum sand content of 5 mg/l at a pumping rate of 61 gpm is desired. Sand content shall be measured by a Rossum centrifugal sand sampler installed as shown on AWWA A-100-84, Appendix D.

C.5 Test Pumping

C.5.1 Time of Tests

After the well has been completely constructed, cleaned out and developed, and the depth of the well accurately measured, notify the engineer to that effect and make the necessary arrangements for conducting a final pumping test. Besides this final test, additional pumping tests during and after construction may be deemed necessary. Perform all tests with equipment and in a manner as hereinafter described.

C.5.2 Test Pump

Furnish and install necessary pumping equipment capable of pumping, through an orifice to the required point of discharge, a minimum of 85 gpm with the pumping level approximately 116 feet below ground, but with satisfactory throttling devices so that the discharge may be reduced to 55 gpm. The engineer reserves the right to change these

requirements if the final well depths vary from those shown in the Well Profile Detail on the plans.

The pump column shall be watertight, even with the pump throttled, so that water level readings in the well can be taken with electric tape.

The pumping unit shall be complete with electric motor or engine of ample power, controls and appurtenances; and shall be capable of being continuously operated without interruption for a period of 24 hours.

C.5.3 Auxiliary Equipment

Furnish all necessary discharge piping and conducting troughs for the pumping tests, which shall be sufficient size and length to conduct water being pumped away from the well. Also furnish, install and maintain office equipment of approved size and type for measuring the flow of water.

To measure the elevation of the water level in the well, an approved air line, complete with gauge, air compressor and check valve, shall be provided. Unless otherwise permitted, securely fasten the air line to the pumping unit and terminate below the desired pumping level stated in the test pump description; in no case shall it be nearer than 2 feet to the end of the suction pipe. In addition, set the test pump that it will be easily possible to insert electric measuring tapes between the pump column and the well casing. There shall be at least 1-inch clearance for this purpose between the pump column and the casing. Vertical clearance between the top of the casing and the base of the pump or supports shall be such that the tape hangs vertically from the reference point to be used for measuring into the well. The pump is to be located in the well, as directed by the engineer. If water level readings cannot be obtained because of equipment failure or improper pump settings, the test shall be voided and no payments made.

C.5.4 Duration of Test

Except as otherwise provided, furnish all labor, motive power, lubricating oil and other necessary materials, equipment, labor and supplies required, and operate the pumping unit at such rates of discharge and for such periods of time as directed. The unit shall be capable of continuous operation for at least 24 hours.

1. The engineer and interested parties will make arrangements with owners of other wells in the vicinity to obtain data during the testing of the new well. Timing and scheduling of testing operations will be such as to make possible collection of such data. The contractor shall furnish labor to take readings at the well at all times while the pump is operating.
2. The pumping shall be done in two stages. The first stage will consist of development pumping at gradually increasing rates set by the engineer until a minimum of 150% of the desired capacity is reached, the discharge is clear, and the well, in the engineer's opinion, has been fully developed. The well will be surged

frequently with the test pump during this period. After completion of the first stage, the engineer will order pumping stopped for a period of about 12 hours.

3. The second stage of pumping will be a capacity test, with pumping rates and duration set by the engineer. Continuous operation of the test pump during the capacity test is essential. Interruption of the test at the prescribed pumping rate for any interval of time for any reasons shall constitute failure upon the part of the contractor and shall void all of the test prior to interruption. No payment will be made for interrupted tests. A copy of this pump test shall be submitted to the Department of Natural Resources by the contractor.

C.5.5 Removal of Test Pump

Removal of the test pump shall not interfere with well recovery readings. These readings will be taken frequently immediately after pump shutdown and at longer intervals for 24 hours or more. Furnish the labor to take recovery readings.

C.6 Samples & Records

C.6.1 Samples of Formations

Keep an accurate record of the location of the top and bottom of each stratum penetrated and save two samples of material taken from each 5 feet of drilling and at every change of formation. Sampling shall be in accordance with the Geological Survey instructions. Unless otherwise specified elsewhere, deliver one set of samples to the owner and one set to the Geological Survey.

C.6.2 Record of Casing Pipe

Keep an accurate record, as assembled, of the order, number, size and lengths of the individual pieces of pipe installed in the well, and deliver that record to the owner.

C.6.3 Daily Reports

Submit a daily report describing the nature of materials encountered, the work done during each day, including the items of work accomplished such as depth drilled, casing set, iron tests, etc., the water level in the well at the beginning and end of each shift, drilling time, weight of tools, and such other pertinent data as the engineer requests that a record is made of. Mail these reports daily to the engineer in duplicate during the period from the beginning of erection of drilling equipment to removal of that equipment.

C.6.4 Driller's Availability

Make arrangements so that the driller can be reached by phone at any time during the working day. The driller shall immediately, by phone, advise the engineer of any circumstances that might alter construction of the well or have an effect in determining where drilling operations might be changed. Failure of the contractor to keep the engineer advised of drilling progress and conditions will result in non-payment to the contractor for items of work which the engineer did not wish performed, e.g., extra length of casing, hole, etc.

C.6.5 Water Samples

Near the end of the test pumping, take two water samples, a minimum of 8 hours apart, to be sent to the State Laboratory of Hygiene, Madison, or a laboratory certified by DHSS under ch. HSS 165. It is the Contractor's responsibility to obtain a safe water certification and he shall take the necessary steps to do so, should the initial samples test unsafe.

Take water samples at the end of the pumping test for a complete NR 809 chemical analysis. The water samples shall be sent to a state certified laboratory for analysis.

Provide a smooth end sampling faucet on test pump discharge pipe from which samples may be obtained.

If the contaminant levels exceed the limits set forth in the drinking water standards, the well shall not be put into service until an adequate treatment facility is available.

C.6.6 Well Construction Report

The well driller shall submit a Well Construction Report to the DNR per NR 812.10(11) with a copy to the owner upon completion of the well.

C.7 Protection Of Water Quality and Disinfection

C.7.1 Precautions to Be Taken

Take such precautions as are necessary or as may be required permanently to prevent contaminated water or water having undesirable physical or chemical characteristics from entering, through the openings made (by the contractor) in drilling the well, the stratum from which the well is to draw its water supply. Also, take all necessary precautions during the construction period to prevent contaminated water, gasoline, or other contaminants from entering the well, either through the opening or by seepage through the ground surface. Chlorinate all drilling fluid mix, make up and mix water to a minimum of 100 ppm, even if from a chlorinated municipal supply. Due to its instability, add chlorine periodically to the drilling mud to maintain a 10 ppm free chlorine residual during drilling operations.

C.7.2 Disinfection

Once the well is completed and before it is test pumped, thoroughly disinfect it in accordance NR 812.22(4), Wisconsin Administrative Code. The chlorine solution shall remain in the well at least 2 hours prior to being pumped to waste. At least 100 ppm of available chlorine shall be obtained for the entire depth of the well.

C.7.3 Corrective Work

In the event the well becomes contaminated or if water having undesirable physical or chemical characteristics does enter the well due to the neglect of the contractor, at contractor expense, perform such work or supply such casing, seals, sterilizing agents or other material as may be necessary to eliminate the contamination or shut off the undesirable water.

C.7.4 Freedom from Sand and Turbidity

Exercise extreme care in the performance of his work in order to prevent the breakdown or caving in of strata overlying that from which the water is to be drawn. Develop, pump or bail the well, by such methods as may be approved by the engineer, until the water pumped from the well is substantially free from sand, and until the turbidity is less than 5 units when tested as described in Standard Methods of Water Analysis. Pumping required to eliminate sand or turbidity due to construction problems caused by the contractor shall be at contractor expense.

C.7.5 Removal of Lost Tools

Remove all bits, drill bars, rods, cables or tools lost in the well if the work can be done in 10 days from the time of the accident. If they cannot be removed in 10 days, the driller should drill past the tools with the full size of the hole. This will only be allowed, however, 100 feet below the anticipated setting of the pump. If the driller cannot drill past the tools, or if the tools are lost where the pump is to be set, a new hole will have to be started.

C.8 Capping

At all time during the progress of the work, protect the well in such manner as to effectively prevent either tamper with the well or the entrance of foreign matter into it and, upon its completion, provide and set a substantial welded cap satisfactory to the engineer.

During the period of placing the inner casing, seal the annular space between the casing and the drill hole with a temporary plug to prevent the entry of foreign material.

C.9 Well Pump & Controls

Furnish and install a submersible well pump rated for a minimum of 55 gpm at a total dynamic head (TDH) of 270 feet. The TDH is based on estimated static and pumping water levels. Therefore, engineer will make final pump selection after the well pump test has been performed.

The submersible well pump shall comply with the latest revision of NR 812 of the Wisconsin Administrative Code.

The well pump shall be capable of running continuously without damage to the motor. Pump water passages shall be designed to handle sandy water without significant abrasion. The pump shall feature stainless steel bowls stacked and rabbet locked together on a four-sided stainless steel shaft. The pump casing shall be stainless steel. The well pump shall be Model 70L07 with 7½ -HP, single-phase, 230-volt motor, with hermetically sealed stator, model S11970 motor as manufactured by Goulds Pump, Inc; Model 60S75-13 with 7 1/2-HP, single-phase, 230-volt motor, model MS 4000 as manufactured by Grunfos Pump Corp.; or Sandhandler Model 75S46017XM with 7 1/2-HP, single-phase, 230-volt motor, as manufactured by Franklin Pump Systems. Set well pump intake at level shown in the Well Profile Detail on the plans.

Furnish and install a Deluxe Franklin Motor control box with relays, overloads, capacitors, and lightning arrestor in a NEMA 3R enclosure as supplied by Liebert AC-4, Siemens, or engineer-approved equal.

Furnish and install a pressure switch capable of setting an acceptance pressure range of 45 to 65 psi and for use with a single-phase, 240 volt, 7½ HP pump motor. Switches manufactured by Square D or Furnas are acceptable.

C.10 Water Service Piping

Water service piping from the well to the building shall be HDPE, SDR 9, ASTM D3350, ASTM D3035, AWWA C901 meeting the requirements of COMM 82.40 and COMM 84, Wisconsin Administrative Code.

C.11 Well Related Plumbing Fixtures – Products & Materials

C.11.1 Domestic Water Piping

C.11.1.1 Below Ground

High Density Polyethylene (PE) Plastic Pipe and Tubing, ASTM D3035, ASTM D3350, AWWA C901, 200 psi, SDR 9

Type K copper water tube, O (annealed) temper, ASTM B88; with cast copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; or cast copper flared pressure fittings, ANSI B16.26.

C.11.1.2 Above Ground

Type L copper water tube, H (drawn) temper, ASTM B88; wrought copper pressure fittings, ANSI B16.22; lead free (<.2%) solder, ASTM B32; flux, ASTM B813; copper phosphorous brazing alloy, AWS A5.8 BCuP. Copper mechanical grooved fittings and couplings on roll grooved pipe may be used in lieu of soldered fittings. Mechanically formed brazed tee connections may be used in lieu of specified tee fittings for branch takeoffs up to one-half (1/2) the diameter of the main.

C.11.2 Pressure Gauge

Furnish round stainless steel case, oil filled, nominal 4-inch diameter, with phosphor bronze Bourdon tubes, 1/2" NPT bottom male threaded connection, and accuracy of 2% of scale range. Gauge assembly shall be complete with brass fittings and brass shutoff valve. Scale ranges shall be from 0 to 100 psi. Gauge shall comply with Comm 84.

C.11.3 Pressure Relief Valve

Manufacturers: Bell & Gossett, A. W. Cash, Conbraco, Watts, Wilkins. Bronze body, pressure actuated, stainless steel spring, test lever, suitable for 125 psig water working pressure at 240° F, standard relief setting of 75 psig, sized for operating pressure of equipment with valve capacity on metal label. Provide AGA, UL or ASME listed and labeled valve.

C.11.4 Smooth End Sample Faucet

Manufacturers: Chicago Faucet, T&S Brass, Watts, Zurn. Chrome plated bronze or brass construction faucet with ½” inlet, lever handle, and plain outlet of minimum ¼” diameter meeting requirements of NR 812.34 and Chicago Faucet No. 4. Locate minimum 12” above floor.

C.11.5 Ball Valves

3" and smaller: Two or three piece bronze body; sweat ends, chrome plated bronze ball; glass filled teflon seat; teflon packing and threaded packing nut; blowout-proof stem; 600 psig WOG. Provide valve stem extensions for valves installed in piping with vapor barrier type insulation. Apollo 70-200, Grinnell 3700, Hammond 8511, Milwaukee BA150, Nibco S580-70, Watts B-6001

C.11.6 Pressure Tank(s)

Manufacturer: Well-X-Trol, Amtrol, Bell and Gossett, Wessels. Vertical steel pre-charged hydro-pneumatic pressure tank, 125 psi ASME labeled construction, complete with replaceable flexible butyl rubber bladder, system connection fitting, Schrader type air charge fitting, steel base ring stand, factory prime and enamel painted exterior finish, ASME pressure relief valve. Materials exposed to water to be NSF or FDA approved for potable water service.

C.11.6.1 Schedule of Fixtures

PT-1 Pressure Tank(s): Well-X-Trol Model WX-453-C, 264 gallons each, 528 gallons total volume (Well-X-Trol Volume), 3” NPTF connection, 45 psi to 65 psi acceptance pressure range, quantity as indicated on drawings.

D Measurement

The department will measure Well Construction & Pressure Tanks, completed in accordance to the contract and accepted, as a single complete unit of work.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.03	Well Construction & Pressure Tanks	LS

Payment is full compensation for furnishing all materials including drilling materials, well pump, and pressure tanks; drilling, sampling, and testing; obtaining all permits; and for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the contract work.

30. Onsite Wastewater Treatment System, Item SPV.0105.04.

A General

A.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.

A.2 Summary

- a. This Section includes the following:
 1. Holding tanks, controls, and accessories for a complete installation.
- b. Related Sections: The following Sections contain requirements that relate to this Section:
 1. Division 2 - Earthwork
 2. Division 15 - Plumbing

A.3 Performance Criteria

- a. Performance criteria for the system is described in Tables 1 and 2 below:

Table 1 SIZE AND ORIENTATION	
Holding capacity	=5 times design daily wastewater flow or 2000 gals, whichever is greater
Horizontal setback	Meets s. Comm 83.43 (9) (i), Wis. Adm. Code
Location to service access	=25 feet to service drive or road measured from service access opening or pump out port

Table 2 OTHER SPECIFICATIONS	
Tank design and construction	Meets ch. Comm 84.25
Tank access	=1 opening having an inside diameter of at least 8 inches.
Alarms or warning system	Meets s. Comm 83.43 (9) (e), Wis. Adm. Code
Water Meter	Meets s. Comm 83.54 (2), Wis. Adm. Code
Anchor for installation in saturated soils	Meets s. Comm 83.43 (9) (g), Wis. Adm. Code and the weight of anchor is = 1.5 x tank volume in cubic feet x 62.4 pounds per cubic foot - weight of tank
Installation inspection	In accordance with ch. Comm 83, Wis. Adm. Code
Management	In accordance with ch. Comm 83, Wis. Adm. Code and this manual

A.4 Definitions

- a. "Cobbles" means rock fragments greater than 3 inches, but less than 10 inches in diameter.

- b. "Service provider" means the individual or company that is responsible for managing and maintaining the holding tank system.
- c. "Stones" means rock fragments greater than 10 inches in diameter, but less than 24 inches.

B Products

B.1 Holding Tank System

- a. Tank Size:
 - 1. Public Facilities. Minimum liquid capacity of a holding tank for public facilities must not be less than 3000 gallons or 5 times the estimated daily wastewater flow whichever is greater as determined in accordance with s. Comm 83.42 (6), Wis. Adm. Code or Table 3.
 - a. Available tank products: Low profile, 3000 gallon, single chamber tanks manufactured by Wieser Concrete 2815 Riley Road Portage, WI 53901, Phone 608.742.4464; Lakeshore Buried Vault Company, Brookfield, WI; Jones Concrete Products Co., Madison, WI; or Crest Products Inc., La Crescent, MN.
- b. Monitoring/Management Equipment:
 - 1. The holding tank POWTS includes the installation of a water meter meeting the AWWA C700 - 90 standards and a direct-reading remote registration system which meets AWWA Standard C706 on the water supply of the facility that discharges to the holding tank. The meter and remote reading system registers in gallons or cubic meters.
 - a. Available water meter products: Badger Recordall Discmeter, 5/8" x 3/4"; Lake Monitors; Niagara; or approved equal.
 - 2. The alarm for the holding tank installation is an audible and/or visual alarm posted in a conspicuous location in the building served or on a post near the tank protected from the weather. The alarm is connected to a float in the holding tank.
 - a. Available alarm products:
 - 1) SJE Rhombus, Model 101.
 - 2) Septronics # 2001.
 - 3) Or approved equal.
- c. Sanitary Piping:
 - 1. 4-inch PVC, complying with specifications of COMM. 84, Table 84.30-3.
- d. Permits:
 - 1. The installing contractor shall be responsible for obtaining a Sanitary Permit from the department or governmental unit having jurisdiction.

C Execution

C.1 Site Preparation & Construction

C.1.1 Site Preparation

Provide a minimum of 3 inches of compacted bedding material under the holding tank. Bedding material shall be sand, gravel, granite, lime rock or any unsaturated soil material of a sandy loam or coarser texture. 100 % of the bedding material passes a ½-inch screen.

C.1.2 Sanitary Permit

Prior to the construction of the system, the installing contractor shall obtain a sanitary permit for the installation. This permit must be posted in a clearly visible location on the site. The installing contractor shall also make arrangements for inspection(s) must also be made with the governmental unit issuing the sanitary permit.

C.1.3 Tank Installation

Take care in setting the tank to avoid damage to the structural integrity of the tank. The excavation for the tank shall provide at least 12 inches of space around the tank to allow free flow of backfill material along the tank walls.

Also,

1. The tank shall be set level.
2. Access openings that terminate at grade and/or less than 2 ft. above the established regional flood elevation (if applicable) shall have water and gas tight access ports. Access openings that terminate at least 4 inches above the surrounding grade and 2 ft. above the established regional flood elevation (if applicable) are not required to have water and gas tight access ports.
3. Provide connection of the holding tank to the sanitary sewer by means of a mechanical compression type joint conforming to s. Comm 84.40, Wis. Adm. Code.
4. Install all access ports so as to permit a minimum of 3 feet of clear space above the port and 2 feet in all directions horizontally from any point of the access port.
5. Below grade connections. Joints between the tank, access ports, access opening risers, and covers shall be watertight if located below finished grade.
6. Where a holding tank is installed in saturated soils (see Comm 85 for the determination of soil saturation), anchor the tank using the following equation:
Weight of anchor = $1.5 \times \text{tank volume in cubic feet} \times 62.4 \text{ pounds per cubic foot} - \text{weight of tank}$.

C.1.4 Monitoring/Alarm Equipment Installation

C.1.4.1 Meter installation

Install the water meter on the water supply discharging to the holding tank. All exterior hydrants are excluded from the metered flow. Install the meter downstream of all point-of-entry water treatment devices. Install a control valve on each side of the meter.

C.1.4.2 Alarm installation

Set the alarm float to turn on the alarm when liquid volume is at 12" below tank inlet invert or at 90% of the liquid capacity of the tank below the tank inlet invert. Install the alarm wiring in accordance to NEC 300 and ILHR 16.23, Wis. Adm. Code.

C.1.5 Backfill

Backfill the holding tank excavation with soil material and tamp into place. The cobble content shall not exceed 35% and no stones will be permitted in the backfill material.

C.2 Operation & Maintenance & Performance Monitoring

User's Manual: A user's manual shall accompany the component. The manual is to contain the following as a minimum:

1. Diagrams of all components and their location.
2. Names and phone numbers of local health authority, component manufacturer or POWTS service provider to be contacted in the event of component failure or malfunction.
3. Information on the periodic maintenance of the component, including electrical/mechanical components.

C.3 Installation Inspection

The installing contractor shall be responsible to coordinate the site inspections during and after the construction. The county or other appropriate jurisdictions in accordance with ch. Comm 83 of the Wis. Adm. Code shall accomplish such inspections.

Prior to Owner acceptance, inspection shall be made in accordance with ch. 145.20, Wis. Stats., and s. Comm 83.26, Wis. Adm. Code, using the inspection form on the following two pages. The inspection of the component installation and/or plans is to verify that the component at least conforms to specifications listed in Tables 1 and 2 of this section. The completed forms shall be submitted as part of the user's manual. (Refer to forms on the following two pages.)

POWTS HOLDING TANK INSPECTION REPORT*(Attach To Permit)*

GENERAL INFORMATION			
Permit Holder's Name	☐ City ☐ Village ☐ Town of	County	Sanitary Permit No.
State Plan ID No.	Tax Parcel No.	Property Address if Available	

TANK INFORMATION		
Type	Manufacturer	Capacity

SETBACKS						
Property Line	Well	Water Service	Building	Service Road	OHWL	Swimming Pool

DEVIATIONS FROM APPROVED PLAN	
Date of Inst. Directive:	Date of Enforcement Order:
Date of Referral to Legal Counsel:	
COMMENTS (Persons present, discrepancies, etc.)	
COMPONENTS NOT INSPECTED	
Plan Revision	Required Signature of Inspector:

30.1.1.1.1.1. Sketch on other side

ELEVATION DATA					
Point	Back sight	Height of instrument	Foresight	Elevation	Comments
Bldg. sewer					
Tank inlet					
Tank outlet					
Tank inlet					
Tank outlet					

Sketch of Component & Additional Comments:

D Measurement

The department will measure Onsite Wastewater Treatment System, completed in accordance to the contract and accepted, as a single complete unit of work.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.04	Onsite Wastewater Treatment System	LS

Payment is full compensation for furnishing all materials and equipment; excavating and backfilling; obtaining all permits; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the contract work.

31. Telephone Service, Madison SWEF, Item SPV.0105.05.

A Description

This work includes all coordination and work by utility and contractor as required to shut off current telephone service to the existing SWEF building and provide underground telephone service from tie-in at existing to new SWEF Building.

Non-metallic conduit required for crossing under paved areas is included under other bid items.

B (Vacant)

C Construction

Make all arrangements and coordinate telephone utility work with Verizon Communications.

Utility will provide telephone service to the SWEF building.

The allowance for telephone utility company charges as specified under the article Utilities shall be incorporated into the lump sum bid price for this bid item. Final price shall be adjusted, if necessary, by contract change order whenever the utility company charge is more than or less than the stated allowance.

Include all other work not incorporated into the utility allowance but necessary for complete installation.

D Measurement

The department will measure Telephone Service, Madison SWEF, completed in accordance to the contract and accepted, as a single complete unit or work.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.05	Telephone Service, Madison SWEF	LS

Payment is full compensation for providing underground telephone service from tie-in at existing to new SWEF Building; furnishing and installing all telephone cable, pedestals and network interface devices; performing all associated coordination; and for furnishing all labor, material, equipment, tools, and incidentals necessary to complete the work as specified herein, subject to final price adjustments for items covered by contract allowances.

32. Electrical Service, Madison SWEF, Item SPV.0105.06.

A Description

This work includes all coordination and work by the utility and contractor as required to shutoff current electrical service to the existing SWEF building, and to provide electrical service from existing source to the meter at the new SWEF Building, in accordance with the plans and as hereinafter provided. The bid item Electrical Service also includes overhead single phase power to the site and to transformers near the proposed building and lift station, including furnishing and installation of transformers and transformer pads; underground single phase service to the new SWEF building; wire and terminations at transformers and at meter sockets; and meters.

Site lighting; site telephone work, and telephone wiring and equipment within the SWEF Building; electrical work and equipment within the SWEF Building including the meter socket, conduit, and SWEF Building electrical system terminations at the main switch; and exterior conduit stub from the meter are included under other bid items.

Non-metallic conduit required for crossing under paved areas is included under other bid items.

B (Vacant)

C Construction

Make all arrangements and coordinate electric utility service work with Alliant Energy.

Utility will provide transformers and transformer pads; wire; and all terminations at tie-in to existing, at transformers and at meter socket; and shall provide and install the meters.

The allowance for electric utility company charges as specified under the article Utilities shall be incorporated into the lump sum bid price for this bid item. Final price shall be adjusted, if necessary, by contract change order whenever the utility company charge is more than or less than the stated allowance.

Include all other work not incorporated into the utility allowance but necessary for complete installation.

D Measurement

The department will measure Electrical Service, Madison SWEF, completed in accordance to the contract and accepted, as a single complete unit or work.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.06	Electrical Service, Madison SWEF	LS

Payment is full compensation for providing overhead single phase electric service from existing source to transformer near lift station, underground single phase electric service to transformer near new SWEF Building, transformers, transformer pads, and all associated coordination; and for furnishing all labor, materials, equipment, tools, and incidentals necessary to complete the work as specified herein, subject to final price adjustments for items covered by contract allowances.

33. Static Scale System, Item SPV.0105.07.

A General

This special provision describes a static scale system to be manufactured, furnished, installed, tested, and accepted at the enforcement / inspection facility.

Data acquired from the static scale system described in this specification must be such that it may be readily associated with other data for the same vehicle into a record that coherently represents data acquired from weigh-in-motion, static scale, and overview camera system.

B System Components

B.1 The Static Scale

1. Scale gross capacity of individual platforms shall be 105,000 pounds for platform 1, 105,000 pounds for platform 2, and 175,000 for platform 3.

2. Each scale consists of three independent weigh bridge structures
 - a. First weigh bridge is 12 feet long by 12 feet wide
 - b. Second weigh bridge is 24 feet long by 12 feet wide
 - c. Third weigh bridge is 44 feet long by 12 feet
3. Minimum of 10-inch thick concrete deck with double mat, reinforced steel
4. Must be NTEP approved
5. Scale pit construction per approved shop drawings
6. 70,000 pounds tandem axle capacity
7. Provide a fatigue life of a minimum of 20 years
8. All welding during manufacturing shall comply with AWS D1.5 certification
9. Surface Preparation and Finish
 - a. Shot blast the weigh bridges to a minimum SSPC-B-SP6 specification prior to painting
 - b. Provide a two part epoxy finish of Carbolite 15L0, or equal to all exterior surfaces of the scale
 - (1) Provide a total Dry Film Thickness of 6-8 mils
10. Deck channel shall be hot dipped galvanized (ASTM A123)
11. Corrugated deck plate for concrete deck
12. The weigh bridge main girders shall be a minimum of W24 x 68 pounds
13. Each of the weigh bridges is supported by the appropriate number of load cells based on their span
 - a. Minimum fourteen 50-ton capacity load cells used per scale
14. Manufacturer or manufacturer's local authorized representative shall supervise the installation of the static scale
15. The static scale shall be a standard production type that is in use in the United States for weight enforcement.

B.2 Static Scale Pit

1. Scale pit per plans and approved shop drawing.
 - a. Pit coping angle shall be 6" x 4" x 5/8" hot dipped galvanized
 - (1) ASTM A123
 - b. SYSTEM Manufacturer shall clean the static scale pit and Engineer will

inspect prior to placement and operation of any components

- c. SYSTEM Manufacturer shall keep the pit and drainage pipes clean during construction
2. All concrete work shall be performed in accordance with the best practice as prescribed by the American Concrete Institute (ACI). All concrete shall be a minimum of 3500 psi @ 28 days.
3. Reinforcing bars are to be equal ASTM A615, grade 40 or 60. Bend bars cold to conform with required details on drawings. Remove scaled, loose flaky rust, dirt, and other coating that would impair bonding. Space bars properly and tie securely in position before placing concrete. Tack welding to keep reinforcing in place is not permitted.
4. Suitable conduit for low-voltage conductor-shielded cable must pass through the pit wall at any point above the pier tops that is convenient. Conduit must extend beyond the pit wall a minimum of 2 inches. For conduit runs up to 50 feet in length, use ¾-inch conduit. Avoid running conduit next to high voltage lines. Provide #10 copper ground lead at instrument location. Connect to 10-foot copper-clad ground rod driven in moist earth. If AC is required in the pit, it shall not run more than 24 inches in parallel to any cell cable.
5. Inside and centerlines of dimensions must be maintained.
6. Pit walls and footing depths as indicated on plans are the minimum recommended where normal soil conditions prevail.
7. If the soil has low load carrying capacity and/or heavy vehicle traffic that will be parallel or near to sidewalls, concrete should be reinforced to the proper strength.
8. Approaches should be equal to half (1/2) the length of the scale, but not greater than 40 feet on each side. The initial 10 feet approaching the scale must be concrete and level.
9. All scales require ground rods through the floor of the scale to the specified depth.
10. It is recommended that the piers be poured as shown on the plan.
11. Angle iron and coping are to be attached to the top wall form at the elevation as shown on the plan.
12. Bumper plates should be placed in their proper location on the inside of the form so they will be flush with the face of the wall. Bolt heads are to be in the wall projecting as indicated in the drawing.

13. Excavation, foundation forms, rebars, and concrete are to be furnished by the contractor.
14. 1500 psf minimum soil bearing capacity is required. The design is adequate for a highway surcharge of 300 psf adjacent pit walls.
15. Work from centerlines when erecting forms and placing foundation bolts.
16. The pit, as shown, is the minimum required to accommodate the scale NBS H-44 requirements and local Weights and Measures may specify additional installation requirements. In order to ensure compliance, consult local governing Weights and Measurers prior to installation.
17. To comply with NBS H-44, any ends of a vehicle scale installed at one location for a period of six (6) months or more shall have a straight approach at least as wide as the platform and at least half the length of the platform. Not less than 10 feet on any approach adjacent to the platform shall be constructed of concrete or other durable material to ensure that this portion of the approach remain smooth and is in the same plane as the platform. When necessary for drainage, the remaining portion of the approach may slope slightly.
18. Since the concrete platform slabs are factory-poured, no field-poured concrete is required for these platform slabs.
19. Vehicles should enter and exit the scale from the approaches only. Cross traffic should be eliminated.
20. It is recommended that the weighbridge be assembled and blocked in the pit before load cells are installed.

B.3 Approach Slabs

The 20-foot concrete pavement approach slabs on both ends of scale pit shall be per handbook 44 and be part of the static scale pit drawing. The expansion joint between the pit wall and the 20-foot approaches shall be 1-inch (25 mm) strip seal expansion joint.

B.4 Duplex Sump Pump with In-Building Alarm

1. Provide and install duplex sump pumps as indicated in the contract documents. Each pump shall be of capacities indicated. The pumps shall be of the automatic, electric motor-driven, submersible type, complete with necessary control equipment. The pumps shall be factory-assembled and tested for operation under water. The pumps shall be furnished complete with cast-iron casing, bronze impeller, stainless steel shaft, sealed heavy-duty ball bearings, water-cooled hermetically sealed motor, built-in automatic reset thermal protection, float switches, and waterproof three-conductor cables and grounding plugs. Provide high water alarm and check valve as specified herein.

2. Duplex sump pumps shall be equipped with an across-the-line magnetic controller in a NEMA 250, type 4 waterproof enclosures. A float switch assembly, with the switch completely enclosed in a NEMA 250, type 4 enclosures, shall start and stop each motor at predetermined water levels. Duplex pumps shall be equipped with an automatic alternator to change the lead operation from one pump to the other, and for starting the second pump if the flow exceeds the capacity of the first pump. The discharge line from each pump shall be provided with a union or flange, a non-clog swing check valve, and a stop valve in an accessible location near the pump.
3. Sump discharge pipe.
 - a. Supply Schedule 40 PVC from pit wall to discharge site.
 - b. Provide one check valve per pump and locate as close to the pump as possible.
 - c. Provide a disconnect union per pump to permit pump replacement.
4. Design pump discharge to prevent backflow from ditch or drain into the scale pit.
5. Equip scale pit with a high water alarm to give early detection of sump failure.
 - a. Pit alarm shall be attached to concrete pier and the float shall be located 1-inch off scale pit floor

B.5 Scale Pit Lighting and Receptacles

1. Provide scale pit lighting switch inside electrical room of the administration building.
2. Provide dual exterior weather resistant bulb 40-watt fluorescent light fixture.
 - a. 12-feet bridge, Three fixtures, 4 feet long with lens cover.
 - b. 24-feet bridge, Two fixtures, each 4 feet long with lens cover.
 - c. 44-feet bridge, Three fixtures, each 4 feet long with lens cover.
3. Attach (6) fixtures to the sidewalls and (2) to the end walls of the scale pit. Lights shall have at least 1-inch spacing off scale pit wall.
4. No receptacles in the same current path as the lighting fixtures although the lights may be on the same breaker as receptacles.
5. Lighting and receptacles shall have quick disconnect in pit.
6. Install one weatherproof GFCI receptacle on the concrete pier underneath each weigh bridge not less than 24 inches from the pit floor.
7. Only watertight conduits are to be mounted on the pit wall.
8. Provide waterproof non-metallic type boxes and conduits in the pit
9. Install one weatherproof GFCI free receptacle for pump power
 - a. Locate receptacle on the concrete pier under the weigh bridge
(1) 24 inches from the pit floor

10. Separate and isolate pump circuit
 - a. From lighting, receptacle or any other circuit
11. The current path shall be free of any GFCI devices.

B.6 Surge Voltage Protection

AC Line Voltage Protector: Used "in-line" with external 115 VAC power line to protect equipment from incoming surges

- a. Clamping Level: 200 Volts
- b. UL 1449 Surge Protection Rating: 330 Volts
- c. Protection Modes: Line to Neutral, Line to Ground, Neutral to Ground
- d. Line Voltage: 120 VAC, 50/60 Hz
- e. Maximum Current Rating: 15 Amperes (1800 Watts)
- f. EMI/RFI Noise Filtration: 50 db. (99.7%) from 100 kHz to 1 MHz
- g. Response Time: <1 Nanosecond
- h. Energy Dissipation: 30,000 Amperes

B.7 Load Cells

1. Mount load cells in such a manner as to be easily replaced
2. Design mountings to provide for thermal expansion and contraction of weigh bridge steel and for shock loading
3. Meet the latest adopted edition of the NIST Handbook 44
4. Must be NTEP approved
5. Minimum capacity of 50 tons.
6. Construct of 304 stainless steel
7. Seal hermetically with a minimum NEMA 6P submersible rating
8. Load cell interface cables shall be stainless steel sheathed for environmental and rodent protection.
9. Provide 150 percent safe overload capability
10. Provide 250 percent ultimate overload capability

B.8 Static Scale Instrument (digital display)

1. Microprocessor based item(s) for:
 - a. Scale read out
 - b. Control and data handling functions

2. Provide microprocessor-based digital instrument with Ethernet weight output to the static scale PC
3. This connection shall provide diagnostics of static scale load cells (load cell raw counts)
4. Shall include software diagnostics to facilitate fault finding
5. Provide a certificate of conformance from the NIST Handbook 44
6. Static scale instrument must be of the same manufacturer as the static scale weigh bridge and WIM weigh bridge
7. Minimum of 15 updates per second
8. One display showing individual axle weights and the summation of the individual weights
9. Shall be suitable for desktop or set-in mounting.
10. Display the raw counts of each individual load cell without disconnecting any of the load cells from the system.
11. Display up to 1 part in 10,000.
12. Adjustable digital filtering
13. Adjustable automatic zero maintenance
14. Motion detection should be selectable from ± 0.5 , ± 1.0 , ± 2.0 , ± 3.0 increments.
15. Static scale instruments shall meet the current specifications of the NIST Handbook 44.
16. The instrument shall be UL/CSA listed
17. Provide one button printing as backup

B.9 Static Scale System Requirements

1. System manufacturer shall provide all software necessary for complete and efficient operation of the static weight enforcement scale systems.
2. Allows the user to dial up and perform remote diagnostics as described below for troubleshooting from a remote location.
 - a. Static scale instrument setup
 - b. View individual live raw counts for static scale load cells

3. System manufacturer shall provide commercially available dial-up software
4. The Static Scale software must provide the following features
 - a. Interface with the static scale indicator and the WIM terminal
5. Allow for adjustments of gross / axle / tandem weight limits (including bridge table) via Interface control document.
6. Automatically determine if vehicles are in compliance to state's weight limits including bridge formula.
7. Shall use the WIM spacing data to automatically determine if all axles are properly positioned on scale.
8. Continuously update WIM calibration based on static weights.
9. Printing requirements include, but not limited to
 - a. Site identification
 - b. All individual platform weights and gross weight
 - c. Time and date

C Warranty

1. The Static Scale equipment shall be warranted by the manufacturer, in writing, against defective in or from material, workmanship, lightning, and to perform as required by these Technical Special Provisions, giving proper and continuous service under all conditions required and specified, or which may reasonably be inferred, for a period of five years from the date of acceptance. The manufacturers routine maintenance schedule shall be stated. The written manufacturers warranty shall be furnished to the department by the contractor at the time the equipment performance supporting data is submitted. The warranties shall also state they are subject to transfer to the department.
2. The static scale equipment weighing instruments, load cells, weigh bridge, deck and hardware shall be warranted by the manufacturer, in writing, against defects in or from material, workmanship, lightning, and perform as required by these Technical Special Provisions for the period of five years or as described in item 1 above from the date of final acceptance of the project. The manufacture shall provide an extended five (5) year warranty on static scale load cells. This warranty shall take effect at the end of the initial five (5) year warranty. This five (5) year warranty shall exclude labor, freight, and travel.

D Measurement

The department will measure Static Scale System, completed in accordance with the contract and accepted, as a single complete unit of work.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.07	Static Scale System	LS

Payment is full compensation for furnishing and installing all materials; coordinating and making all utility hook-ups; making the system operational; testing; providing required training and warranties; and for furnishing all labor, supervision, equipment, tools, and incidentals necessary to complete the contract work. Materials and equipment included in the Static Scale System are a Triple Platform Static Scale including instrumentation, printer, four-line scoreboard, cabling, pre-formed decks, pit construction and excavation. Scope of work includes setting load cells and weighbridge, backfilling with existing excavated materials, any gravel to complete scale, any backfill or extra fill to complete scale and warranty, and calibrating and testing.

Concrete Pavement Approach Slabs will be paid under a separate bid item.

34. Weigh-In-Motion System, Item SPV.0105.08.

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14		Payment
ASTM E 1318-02 For Weigh-In-Motion System		

1 Introduction

Install a Weigh-In-Motion (WIM) Sorting System to be utilized at the Madison SWEF to pre-weigh vehicles and provide direction to vehicles in motion as they approach along the mainline towards the Weigh Station. Changeable Message Signs (CMS) will be utilized along the mainline to direct vehicles to report or bypass the weigh station based on their perceived level of compliance as determined from the mainline pre-screening WIM system. The system will also include Open/Closed Signs and Weigh Station Changeable Message Signs (CMS).

A vehicle that has been directed to enter the weigh station will be screened once more on the ramp. Based on the results of this second screening, automatic directional signals

shall direct the vehicle to either bypass or report to the scale house for further inspection. The sort decisions will be based on compliance of speed, side-to-side balance, height limit, axle weights, axle group weights, and gross vehicle weights with the pre-set tolerances.

This system shall also consist of two Virtual WIM Stations; one located on USH 51, north of County Highway B and the other on County Highway N, south of USH 12/18. These proposed Virtual WIM Systems will provide coverage of the two main bypass routes for the Madison SWEF, and therefore shall provide information regarding commercial vehicles bypassing the station.

As part of this project, Wisconsin DOT will be deploying a PrePass E-Screening System to interface with the mainline WIM Sorting Systems. The WIM Vendor must be able to successfully interface with the E-Screening System and provide consistent messages when notifying vehicles. This must be a fully integrated system.

The Mainline and Ramp WIM Systems shall include various components that interact together. The components shall include the following:

- Weigh-In-Motion (WIM) Scales
- Overview image videocapture
- Lane directional signals for mainline and ramp systems
- WIM computer system
- Axle and loop detection
- Overheight detector
- Printer
- Weigh Station Changeable Message Signs (CMS)
- Open/Closed sign
- On-site communication system
- AVI (automatic vehicle verification) with PrePass Interface

The scope of work is to supply and install the following:

- WIM scales, axle sensing, loops, and cabinet.
- Lane directional signals including support structures.
- Overheight detection installation.
- Overview image camera installation.
- Tracking loops to activate lane directional signals and monitor traffic flow downstream of lane directional signals.
- New communications conduit and wiring for all new equipment.
- Power wiring and conduit.
- Weigh Station Changeable Message Signs.
- Open/Closed Sign
- On-site Communication System

The objective of the department is to have a fully operational Mainline and Ramp Sorting Systems capable of accurately and automatically pre-screening vehicles in motion for

enforcement purposes. Based on the weights obtained from the WIM screening, the system shall automatically direct the selected vehicles to the enforcement scales, as illustrated in the attached plans and these specifications.

The purpose of this project is not for the research and development of a system which might perform the objectives as described above. Therefore the contractor shall be required to furnish documentation which demonstrates to the satisfaction of the department that all equipment proposed for use in the Mainline and Ramp WIM Sorting System is of standard manufacture; that the manufacturer has had similar equipment available for purchase for not less than ten years; and has a proven acceptable performance history while in use under conditions similar to those for the intended use.

As a minimum, the equipment documentations provided by the contractor shall include the following for the mainline, ramp and virtual WIM Systems:

1. Detailed description of how the system requirements will be met.
2. Drawings showing control and display panels with descriptions.
3. Manufacturer's name and model number, supported by descriptive material for (but not limited to) the standard package components with all accessories identified under "Description." Submittals shall be supported by descriptive material, such as catalog cuts, diagrams, and other data published by the manufacturer, to show conformance to specifications and plan requirements

2 Mainline & Ramp WIM Operational Overview

The Mainline and Ramp WIM Sorting Systems shall consist of the following subsystems:

1. Mainline WIM System
2. Mainline Lane Control System
3. Mainline Compliance System
4. Enforcement Camera System
5. Ramp WIM system
6. Ramp Lane Control System
7. Station Computer system
8. Data Collection System

2.1 Mainline WIM System

Commercial vehicles approaching the weigh station shall be directed into the right hand lane by means of static signing as provided by the Wisconsin Department of Transportation. A vehicle approaching the weigh station will pass over the Mainline Weigh-In-Motion (WIM) system, which is embedded in the highway approximately 3000 feet prior to the weigh station exit ramp. The right lane will be equipped with WIM Scales that meet ASTM E 1318-02 Type III accuracy and reliability. WIM electronics will be located at the roadside adjacent to the WIM scales and sensors, and will process the information collected by the in-road equipment.

The WIM system will collect axle weight and spacing, vehicle speed, classification and other relevant data to create a vehicle record. An overview image of the passing vehicle will be combined with the vehicle record. Based on a comparison of the vehicle record to the parameters set by the station operator, the WIM system will make a sort decision and advise the driver to either exit or bypass the weigh station via the changeable message signs (CMS) located on the side of the road. However, the actual sorting operation can be overridden by the operator using the manual console control in the weigh station. Non-violating vehicles may be randomly selected from the mainline for visual inspection at the scale house.

An AVI detection system shall be included to identify PrePass vehicles. This shall be provided separately by PrePass, but shall be integrated into the WIM check system. The Mainline WIM system will be such that a vehicle may be called in to report based on its PrePass credential check, as well as its WIM weight check.

A vehicle classification system shall be installed in the left lane in order to detect commercial vehicles bypassing the scales in the right lane.

2.2 Mainline Lane Control System

Changeable Message Signs (CMS) shall be used to communicate with the driver after a mainline vehicle analysis has been completed. The Lane Control System (LCS) shall consist of two changeable message signs and three inductive loops, which is installed along the side of the roadway approximately 1200 feet from the advance WIM system. The LCS system shall be controlled by the roadside WIM electronics, which receives the sort decision from the Station Computer. The LCS system ensures that the sign ON/OFF switching is synchronized according to the detection and tracking of a vehicle passing over strategically placed loops. In this way, only the vehicle for which the message is intended will see the illuminated sign.

The WIM Vendor will co-ordinate efforts with PrePass to ensure that no conflict occurs within the signing sets, i.e., there shall be no contradictions between the roadside signs and the in-cab transponders.

Typical roadside sign messages are as follows:

Message 1: TRUCK MUST EXIT
TO WEIGH STATION

OR **Message 2:** TRUCK BYPASS
WEIGH STATION

2.3 Mainline Compliance System

A compliance system shall be located on both lanes of the mainline downstream of the ramp exit. The system shall consist of two sets of piezoelectric vehicle classification configurations to track the commercial vehicles that bypass the weigh station. A WIM scale shall also be located on the ramp in order complete the vehicle tracking system.

2.4 Enforcement Camera System

The enforcement camera system will consist of an overview image camera mounted alongside the roadway on the Mainline. This camera will capture an image of passing commercial vehicles to be linked with the vehicle record as an identifier. The camera will be capable of full color photos during daytime operation, and black-and white near-infrared images during nighttime operation. The camera system electronics, which will be located with the other System Electronics, will store the image and will link it with the correct vehicle record.

2.5 Ramp WIM System

The accuracy of the WIM system conform with ASTM E 1318-02 Type III “Standard Specifications for Highway Weigh-in-Motion (WIM) Systems with user Requirements and Test Methods” performance requirements for a Type III system. Calibration and accuracy tests shall be performed as specified below. The contractor shall ensure the roadway meets the requirements of Section 6 of ASTM E 1318-02.

The WIM system shall be provided with a roadside cabinet to house the WIM electronics and/or the WIM computer and its peripherals. The WIM computer and its peripherals may optionally be installed inside the Scale Building.

As commercial vehicles enter the weigh station exit ramp at low to medium speeds (10 to 40 mph), the sorter system will continuously and automatically collect truck information including overheight, speed, gross vehicle weights, axle weights, axle spacing, axle groups, and axle imbalances. From this data, the WIM System will determine whether the vehicle is compliant. Violating PrePass vehicles from the mainline will be directed to report to the static scale via an in-cab transponder notification. All vehicle information, including violation information, will be determined in real time and shall be displayed on the scale house operator console.

The system will function under either manual or automatic control. Under automatic control, the compliance system will automatically direct a suspected violator to the static weigh scales and compliant violators to exit the station. A manual console may be used to override the system and will allow the operator to direct all vehicles to either the scale or bypass lanes. The WIM computer will not be able to direct vehicles according to vehicle information collected in this mode, but will continue to display vehicle information to the operator.

The system will have the ability to track the suspect violators using in-road inductive loops while on route to the static scales.

The manual Console will provide manual control to the Weigh Station for the operation of the Changeable Message Signs, Open/Closed Signs, and the Control Gate.

The system should be able to collect continuous data on the vehicles entering the station for statistical analysis. The data collection system should save vehicle information in a

compressed format complete with a date and time stamp. As a result, the information can be downloaded and, with the aid of commercially available software, the user will be able to generate reports based on user inputs. The stored data must be remotely accessible by telephone modem communications.

2.6 WIM Scale Auto-Calibration

To eliminate costly ramp calibrations the ramp WIM scales shall electronically interface with the static scale. On a pre-selected schedule the static scale shall ensure WIM accuracy and calibration.

Calibration of the WIM system shall be automatic and performed by electronic recording of WIM and static weights on 50 vehicles from the vehicle stream which are loaded to within 75% of the legal allowable limit.

Acceptance testing shall confirm the WIM accuracy performance which shall be verified by printing an electronic database. This database shall be created by continuous (24/7) electronic recording of vehicles from the vehicle stream, which are class nine configuration and loaded to within 75% (60,000 lbs) of the legal allowable limit. The actual stable static weights and WIM weights shall be saved in a common database to determine WIM scale accuracy compliance, as opposed to the method described in ASTM E 1318-02. This database is to be easily accessible to state personnel and shall be printed on a weekly basis throughout the continuous operating test.

The accuracy requirements described in ASTM E 1318-02 will remain in effect. Vehicles that traverse the scale with live loads, or liquid loads (unstable static weight) shall not be considered. The accuracy requirements described in ASTM E 1318-02 shall remain in effect. Vehicles that traverse the scale with more than a 10% speed variation shall not be considered. Vehicles shall be first weighed by the WIM System, then by the Static Scale System.

2.7 Ramp Lane Control System

The ramp lane control system shall consist of an overhead LED CMS system that is linked to the Ramp WIM system. This sign will display a green arrow to an oncoming truck if it is cleared to bypass the static scale; otherwise it will display a red X as a signal to report. The sign will be supported on a pole/mast arm structure.

2.8 Station Computer System and Operator Interface

Using the Station Computer, the operator may set the sorting threshold and allow for random sorting. The sorting threshold determines at what percentage of legal weight a vehicle must be measured to be required to report. In this way, the operator may set the WIM to bring in the maximum number of trucks that the station can process, without exceeding the station capacity. Random sorting allows the operator to require a set percentage of compliant trucks to report. This allows the enforcement officials to perform random safety checks on otherwise compliant trucks.

The computer system will receive the WIM record from the roadside WIM electronics at the ramp location. The sorter computer contains electronic files that will be used to ascertain weight compliance. After the sorter computer creates the WIM record, it will immediately begin to analyze the data contained in the record in order to determine whether the vehicle weights and dimensions are within local compliance regulations. If the measured vehicle weight is within the allowable limits, the driver will be given a bypass message through the ramp lane control system. If the vehicle is not compliant or if it is randomly selected for inspection, the driver will receive a message to report to the weigh station.

2.9 Data Collection System

Vehicle information is to be collected continuously by the roadside WIM electronics at the Mainline and Ramp WIM locations. This information shall be made available to the user and a variety of reports summarizing the data can be generated. This data can be shared between departments if the agency responsible for weight enforcement is separate from the roadway maintenance, planning and/or design departments.

2.9.1 Capabilities

An operator at the site may download the vehicle data directly from the roadside WIM System Electronics, or the data may be transferred to a remote location via modem.

Manufacturer host software can be used to automatically call one or several WIM systems to obtain traffic data from the site. The user configures the frequency of the calls and the information to be obtained. Once the data has been obtained, office analysis software capable of computing various classification schemes shall be used to provide various report capabilities based on the data collected. This system shall store a least 60 days of vehicle records (over 2 million vehicle records) in a compressed format.

2.9.2 Information Available

The following information shall be made available from the data collection feature of the Mainline and Ramp WIM systems:

- Reports over any selected time period in hourly increments, daily, weekly, or monthly.
- Summary of vehicle speeds.
- Summary of vehicle classification counts.
- Equivalent Single Axle Load (ESAL) count.
- Reports on the number of violating and non-violating axles, axle groups and gross vehicle weights.
- User selected reports based on adjustable parameters such as periods and vehicle types.
- Customization for generating reports for specific needs that are not available using basic parameters.

3 Virtual WIM System Operational Overview

Two Virtual WIM Systems shall be located on County Highway N south of its interchange with USH 12/18, and on USH 51 north of County Highway B. These two

locations shall provide coverage of the major roadways used to bypass the main weigh station and shall relay that information to the main weigh station.

All vehicles approaching the Virtual Weigh Station Systems shall produce a vehicle record containing an overview image, various weights, and speed, as well as classification information. The Virtual Weigh Station Systems shall determine whether each vehicle is weight compliant based on its allowable weights as set by the weigh station operator.

The Virtual Weigh Station System shall trigger an overview image camera system to capture an image of each vehicle as it passes the WIM Scales and will link each image with the appropriate WIM vehicle record.

Based on the parameters set forth by the user, images of commercial vehicles can be collected and stored by the System Electronics and relayed to the weigh station for all commercial vehicles or for only violating commercial vehicles. The user can also identify the selection criteria for a violating commercial vehicle, i.e. overweight, over length, speeding, etc.

The combined data (image and vehicle record) will be transferred to the central computer located at the weigh station. After the central computer has received the data, any computer with network access will be able to connect to the central computer and view the captured images and vehicle records of the suspected violating vehicles.

4 WIM System Functional Requirements

4.1 Mainline

4.1.1 WIM Scales

The accuracy of the WIM system will be in conformance with ASTM E 1318-02 “Standard Specifications for Highway Weigh-in-Motion (WIM) Systems with User Requirements and Test Method” performance requirements for a Type III system.

The contractor shall grind the concrete roadway beginning 200 feet prior to the scale location and ending 100 feet after the scale location, for a total of 300 feet, with a minimum 36-inch blanket grinder to ensure the roadway meets the requirements of Section 6 of ASTM E 1318.

Construction time, and the total lane closure time, shall not exceed past 14 hours per duration (consecutive closure time), including the time required for grinding and scale installation.

The WIM scales shall be constructed of two independent weighing platforms placed across a roadway. The WIM scales shall measure approximately 144-inches x 38-inches including frame. Each scale module shall be a self-contained weighing unit. Each scale module shall measure approximately 72-inches x 38-inches including frame.

The WIM scales shall operate properly in a temperature range of -40°F to +160°F. The WIM scales shall be weather-sealed. The WIM scales and their frames shall be rust proofed. All installation hardware shall be either stainless steel or rust proofed.

There shall be two scale frames into which the two scale modules are mounted. The WIM scale shall be installed flush with the road surface.

The WIM scales and frames shall be grounded per manufacturer's recommendations. The signal processing electronic components/modules shall be protected against lightning.

4.1.2 Axle Sensors

The Mainline WIM system may use axle sensors in each lane for WIM or classification operation. If used, the axle sensors shall be Class I piezoelectric and approximately 12 feet in length.

The axle sensors shall be installed below the road surface. The axle sensors and their electrical wiring connector shall be completely water tight and sealed.

4.1.3 Detector Loops

Each detector loop shall have a minimum loop area of 6-ft x 6-ft with 45° angle cuts at the corners. Detector loops shall conform to WisDOT standard specifications.

Loop wire shall be 1 conductor, 14 AWG, IMSA 51-5. Loop leads must be 2 conductor, 14 gauge, IMSA 50-2 cable.

All saw-cut loops shall be sealed with 3M loop sealant.

For each CMS there shall be a detector loop. Loop detectors shall be provided for interface to these detector loops. Loop detectors shall be installed in the WIM system electronics of the Mainline WIM system. The Mainline WIM system shall use the signals from these detector loops to switch the message of each CMS. CMS signs shall be switched in a tracking sequence to direct a sorted vehicle to enter the weigh station.

4.1.4 Compliance System

The compliance system shall consist of vehicle detection loops and axle sensors in the following configuration:

"loop -- axle sensor – axle sensor -- loop".

The compliance system shall monitor vehicles signalled to bypass or report the Weigh Station. It will be interfaced to the WIM Computer.

An alarm will be sounded on the manual console in the event that a commercial vehicle does not take the lane as directed by the Lane Control Signals.

4.1.5 WIM Electronics

The System Electronics shall be capable of receiving and analyzing the data gathered

from the Mainline and Ramp WIM Sorting System locations. The Electronics shall also be responsible for communicating and transmitting vehicle weight data from the WIM site to the SWEF building.

The System Electronics shall be capable of receiving inputs from the WIM scales, loops and piezoelectric sensors, as well as serial and digital devices. Output control options shall be included for a variety of serial, digital and AC power devices, such as CMS, LCS and printers.

The system shall be compatible with automatic vehicle identification (AVI) equipment, as specified by PrePass, including communications ports and software.

All sensor modules shall be field replaceable and every module shall feature self-testing and built-in fault diagnosis.

The Mainline WIM system shall be provided with a roadside cabinet to house the System Electronics, the WIM computer and its peripherals and the overview image freeze frame camera equipment. The Overheight unit electronics located at the Ramp WIM location shall be housed in the Ramp WIM cabinet, as well as the other system peripherals at the location. The electronics for the AVI reader located on the Mainline WIM section shall be supplied by PrePass.

The roadside cabinet shall be lined and insulated and shall be installed with a fan. All cutouts and openings shall be vermin proofed.

All wires from scales, offscale sensors, axle sensors, loops, sign control lines, shall be terminated on terminal strips or screw terminal connectors. The terminal strips shall be identified by terminal strip number and screw connection number. These terminal strips shall be readily accessible. All cables shall be long enough to easily reach these terminal strips. Terminal strips, splices, or other type of connections prior to these standard terminal strips shall not be allowed except for splicing of a loop to a shielded twisted loop lead.

All AC power connections shall be shielded to prevent electrical shock.

The System Electronics shall abide by the following requirements:

a. Communications

1. On-board Ethernet interface (wireless or fiber)
2. One RS-232 serial interface dedicated to external interface.
3. One RS-232 serial interface dedicated to remote administration facilities (modem dial-in).
4. Local user interface for system configuration and fault diagnosis.
5. Remote administration via Telnet or Windows remote desktop.
6. Remote file download via FTP.

b. Peripherals

1. Non-volatile storage for vehicle information to prevent data loss during power outages:
2. Sensor inputs from WIM Scale, loop and Piezo.
3. Output control for CMS and LCS.

c. Software

1. Records data logs on operational status, power supply condition and safety system activity.
2. Weight Compliance and Classification with user-defined classification scheme.
3. Serial output compatible with Help, I75 and others.
4. Automated Mainline and Ramp Weigh Stations.
5. Data Analysis and Reporting.

d. User Interface

1. Local through handheld keypad or laptop PC.
2. Remote through a dial-up modem.

e. Digital I/O Module

1. Report on rising edge, falling edge or both.
2. Adjustable input debounce.
3. Control output state, single pulse, or square wave
4. Adjustable timeout on inputs

4.1.6 Video

The Camera System shall consist of the following system components:

1. Color and Black/White video camera
2. Illuminator system
3. Video capture system

The video system shall monitor traffic flow on the mainline. It shall capture still images of trucks having violations for identification and enforcement purposes. The images shall be displayed on an operator interface located in the scale house. Each vehicle record number shall be displayed with the vehicle image.

One camera shall be provided and installed on a pole located near the Mainline WIM location. The camera shall provide overview images of the passing commercial vehicles, detailing their cab and side. Color images shall be provided for daylight use, and black/white images shall be provided for night use.

The video capture system shall be located in one of the System Electronics. The video capture system shall provide control and display facility to display video outputs from one source to one monitor.

4.1.7 CMS

The Mainline Lane Control System (LCS) shall consist of the following system components:

- a. 2 x Changeable Message Signs (CMS)
- b. Detector loops as needed to track vehicle compliance.

The LCS shall direct vehicles to enter the weigh station or bypass the station, based on the results of the mainline sort decision.

The LCS shall consist of two CMSs that are sequentially switched by the Mainline WIM system. The LCS, under control of the Mainline WIM system, shall synchronize the sign switching upon detection of the tracked vehicle passing over or through strategically located detector loops.

The LCS, under control of the Mainline WIM system, shall also be consistent with the PrePass notification signal to the PrePass in-cab transponder. The WIM System, upon notification from PrePass, shall blank all CMS such that all messages regarding truck compliance and reporting instructions are decided by PrePass and communicated via transponder.

Each CMS shall be capable of displaying the following two (2) messages:

Message 1:

TRUCK MUST EXIT
TO WEIGH STATION

Message 2:

TRUCK BYPASS
WEIGH STATION

Each message character shall be 5.5 inches high. The sign shall have a viewing angle of 90 degrees horizontally, and 40 degrees vertically.

The CMS shall be mounted on a breakaway steel sign support which meets crash requirements as set forth by NCHRP 350 and approved by an engineer licensed in the state of Wisconsin.

The messages must be clear and legible under any lighting conditions. When not energized, the sign shall completely blank out without any ghost images.

4.2 Ramp

4.2.1 WIM Scales

The accuracy of the WIM system will be in conformance with Type III ASTM E 1318-02 “Standard Specifications for Highway Weigh-in-Motion (WIM) Systems with User Requirements and Test Method” performance requirements for a Type III system.

The contractor shall grind the concrete roadway beginning 200 feet prior to the scale location and ending 100 feet after the scale location, for a total of 300 feet, with a minimum 36-inch blanket grinder to ensure that the roadway meets the requirements of Section 6 of ASTM E 1318-02.

Construction time, and the total lane closure time, shall not exceed past 14 hours per duration (consecutive closure time), including the time required for grinding and scale installation.

The WIM scales shall be constructed of two independent weighing platforms placed across a roadway. The WIM scales shall measure approximately 144-inches x 38-inches including frame.

Each scale module shall be a self-contained weighing unit. Each scale module shall measure approximately 72-inches x 38-inches including frame.

The WIM scales shall operate properly in a temperature range of -40°F to +160°F.

There shall be two scale frames into which the two scale modules are mounted. The WIM scale shall be installed flush with the road surface.

The WIM scales shall be weather-sealed and water tight. There shall be no intrusion of water, ice, snow, salt, debris, dirt, moisture, or sand into the scales.

The WIM scales and frames shall be grounded with ground rods. The signal processing electronic components/modules shall be protected against lightning.

The WIM scales and their frames shall be rust proofed. All installation hardware shall be either stainless steel or rust proofed. All surface mounting bolt and service holes shall be sealed.

4.2.2 Axle Sensors

The Ramp WIM system may use axle sensors in the ramp exit lane for WIM operation prior to the point where the roadway splits into two lanes. If used, the axle sensors shall be Class I piezoelectric and approximately 12 feet in length.

The axle sensors shall be installed below the road surface. The axle sensors and their electrical wiring connector shall be completely watertight and sealed.

4.2.3 Detector Loops

Each detector loop shall have a minimum loop area of 6-ft x 6-ft with 45° angle cuts at the corners. Detector loops shall conform to WisDOT standard specifications.

Loop wire shall be 1 conductor, 14 AWG, IMSA 51-5. Loop leads must be 2 conductor, 14 gauge, IMSA 50-2 cable.

All saw-cut loops shall be sealed with department-approved loop sealant.

All loops shall be sealed with department-approved sealant.

For each CMS there shall be a detector loop. Loop detectors shall be provided for interface to these detector loops.

The Ramp system shall use signals from these loops to switch the lane directional signals and the CMS located downstream of the Static Scale.

4.2.4 Overheight Detection

An overheight vehicle detection system shall be installed at the Ramp WIM system location. The overheight system shall be designed such that an alarm will sound for objects that are at least two (2) inches in diameter and one (1) inch above the line of detection.

4.2.5 Electronics

The Weigh-In-Motion (WIM) Interface Electronics shall be located next to the weigh in motion scales in a roadside cabinet. The weigh in motion electronics will be responsible for retrieving truck data and communicating it to the sorter computer in the scale house.

The electronics should include interfaces to the following components:

1. Weigh-in-Motion scales
2. Axle sensors
3. Loops
4. Overheight detector
5. Offscale detectors
6. Operator display
7. Lane directional signals

The electronic system must be of a modular design to aid in system maintenance, troubleshooting and in-field servicing.

All components of the electronic system, including inductive loop detectors, shall contain necessary electrical protection to prevent damage from electrical surges, spikes and the effects of lightning.

The system must be of a durable, industrial design and construction and enable continuous operation, with automated startup in the event of a power outage.

All sensor and ancillary equipment connections must be conveniently located on the system front panel. All connections, where possible, should be a plug-in, quick-connect style.

Where possible, all printed circuit boards and components should be of a commercially available design. This includes, but is not limited to; the system central processing unit (motherboard) and CPU related interfaces such as digital input/output interfaces.

The specifications for the Ramp WIM system electronics are to follow the minimum specifications as set out for the Mainline WIM Electronics. The Ramp WIM electronics and software are to provide the same basic functions as defined in the specifications for the Mainline WIM electronics.

All cutouts and openings in the electronics housing cabinet shall be vermin proofed.

All wires from scales, offscale sensors, axle sensors, loops, sign control lines, shall be terminated on terminal strips or screw terminal connections. The terminal strips shall be identified by terminal strip number and screw connection number. These terminal strips shall be readily accessible. All cables shall be long enough to easily reach these terminal strips. Terminal strips, splices, or other type of connections prior to these standard terminal strips shall not be allowed except for splicing of a loop to a shielded twisted loop lead. All AC power connections shall be shielded to prevent electrical shock.

4.2.6 LCS

A Lane Control System (LCS) shall be located on the ramp prior to the sorting point. The Lane Control System consists of the following components:

- Two (2) Directional Signals with Red “X”, Green “↓” graphics.

- One (1) Directional Signal with Green “↙”, Green “↘” graphics.

- Support Structures and base to suspend the signals (as listed in a) above the lanes of travel.

- A pole and base will provide support for signals.

The LCS CMS shall abide by the same requirements as specified in section 4.1.7 (CMS Specifications).

The support structure and base will be designed to meet department requirements.

Two (2) message signs shall be located downstream of the static scale and mounted on an overhead pole. All CMSs shall be constructed using the same technology.

The CMS mounted over the left lane shall display a static “LEFT LANE” sign above the CMS and shall have the following message options:

Message 1:
STOP

Message 2:
OK
GO AHEAD

The CMS mounted over the right lane shall display a static “RIGHT LANE” sign above the CMS and shall have the following message options:

Message 1:
TURN INTO LOT

Message 2:
OK
GO AHEAD

A message shall be displayed for every commercial vehicle.

4,3 Scale House

4.3.1 Operator Display

The system shall provide an operator display at the scale house. The operator can monitor vehicle movements, view and print reports and adjust system parameters, i.e., alter message signs, adjust random sorting %, adjust overweight %, etc., using the operator console and the operator display. The operator display contains the following windows:

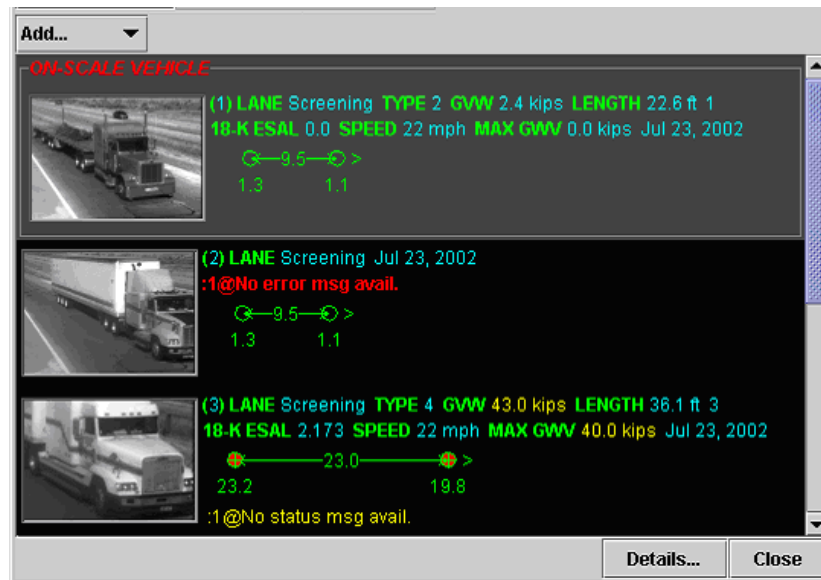
- Vehicle Display Window (displays will vary by manufacturer)
- Station Controls
- Manual Override Controls

The Vehicle Display Window shall display:

- ESALS,
- speed,
- gross vehicle weight,
- time and date,
- individual axle weights,
- spacing, and
- tandem weights as measured by the WIM Computer.

This display shall also provide control over the system sorting parameters. Using this screen, the operator shall be able to control the changeable message signs located on the mainline.

Each vehicle record shall contain a digital image of all vehicles and shall be similar to the following examples.



4.3.2 Station Controls

A Station Controls Window shall be provided to set the system parameters which control the sorting boundaries used when directing vehicles. The control window shall offer control options similar to those illustrated below.



4.3.3 Manual Override Console

A Manual Override Console shall be provided as an interface that allows the operator to

override the Mainline and Ramp WIM Systems in order to gain control of various system components. The Manual Override Console shall be similar to the one illustrated on the following page with additional switches installed to control the changeable message signs downstream of the scale house.



4.4 Station Computer

The Station Computer shall provide the following functions:

1. Perform single-lane WIM operation. (WIM Computer only)
2. Weigh all vehicles travelling on the right lane. (WIM Computer only)
3. Classify all vehicles travelling on all instrumented lanes of the highway.
4. Perform weight compliance analysis on vehicles in accordance with Wisconsin DOT regulations. (WIM Computer only)
5. Perform sorter operation in accordance with decisions based on weight compliance analysis, other violations (speeding, improper manoeuvre, sudden speed change, etc.), Station Control Console selection/override, and operator selected action.
6. Insert sequence numbers for vehicle records for tracking purposes.
7. Track vehicle movement in the execution of sorter operation.
8. Control message display of the CMS/LCS of the LCS to synchronize with the movement of a vehicle being tracked.
9. Perform data collection, data storage, file management and report generation functions for collected vehicle information.

4.5 WIM Computers

The combination of the Station Computer and Operator Display (WIM Computer) shall have client applications to:

1. Display operation status and control of the Mainline and Ramp Sorter Systems.
2. Display vehicle records of the Mainline and Ramp WIM systems.
3. Print display screen of the Mainline and Ramp Sorter Systems.
4. Generate reports from vehicle records.
5. Display and print generated reports.
6. Set up and configure the operation of the Mainline and Ramp WIM systems.

7. Set up and configure the operation of the Mainline and Ramp Sorter Systems.
8. Initiate and reset traffic counting operation of the Mainline and Ramp WIM Sorter Systems.
9. Perform maintenance functions of the WIM systems.
10. Set up and control the operation of the LCS and CMS.

The system status window shall display the following information:

1. Time and date
2. Overweight violation threshold setting
3. LCS and CMS control selections: automatic (by WIM operation) or manual (by operator action)

The WIM Computer shall insert sequence numbers to vehicle records to correspond to the sequence of arrivals at the WIM location. A vehicle record shall consist of the following information for display:

1. Vehicle record number
2. Vehicle lane
3. Vehicle weights; GVW and individual axles
4. Vehicle speed
5. Number and spacing of axles
6. Total vehicle length
7. A side-fire image of the vehicle cab
8. 1-line error message to indicate either type of violation or other information

A vehicle record shall be displayable in either graphic form or in text form, as per manufacturer's discretion, and as indicated examples below:

GRAPHICAL DISPLAY FORM

256)	LANE #1	TYPE 12	GVW 57.1 kips	LENGTH 67 ft
	18-K ESAL 1.60	SPEED 62 mph	Sat Jul 1 15:30:45, 1992	
	MAX GVW 80 kips			
|-----67 ft----->|				
	o o	o o	o	
	11.8 11.9	11.7 11.5	10.2	

Real Time View					11:23:17 PM	
02528	2:24p	4-Mar-1992	Lane:1	Cls:9	ESAL:2.15	Spd:54
Grs:68880						
1.....2.....3.....4.....5						
|---12.8---|-4.4-|-----28.9-----|-4.4-|						
|-----17.2-----|						
|-----37.7-----|						
|-----50.5-----|						
Axle	1	2	3	4	5	
Rght	4960	8220	8580	5300	5360	
Left	5480	9580	7860	5920	7920	
Totl	10440	17500	16440	11220	13280	
Tandem		33940		24500		
InBr	1-3	44380	2-5	58440		

The length from axle to axle shall be shown on a linear scale with axle spacings plotted below the scale line. An asterisk or red text shown at the axle spacing shall indicate the location of an overweight axle or axle group.

When a vehicle passes over the WIM scale, its corresponding vehicle information consisting of vehicle configuration (i.e. number of axles and their groupings) and axle spacings are displayed at the top window.

An alternate to the first format, graphical as above, is a tabular presentation as below OR, as designed by the manufacturer and approved by the state.

TEXT DISPLAY FORM

256) LANE #1 TYPE 12 GVW 57.1 kips LENGTH 67 ft			
18-K ESAL 1.60 SPEED 62 mph Sat Jul 1 15:30:45, 1992			
MAX GVW 80 kips			
	UNIT SEPARATION (in)	WEIGHT (lb)	ALLOWABLE (lb)
1		10,221	20,001
2	116	11,501	17,001
3	54	11,694	17,001
4	450	11,892	17,001
5	56	11,826	17,001

The WIM Computer must display weighing operation advisory information as follows:

- Missed Scale - A vehicle has missed the scales, i.e., loops triggered but no axle counts.
- Offscale - One or more of the offscale detectors was triggered during the weighing operation
- Traffic is backing up close to the WIM scale. A traffic backup has cleared.
- Vehicle speeding
- Vehicle missed tracking loop detector
- Vehicle entered wrong lane
- Vehicle changed speed over scale

The WIM Computers shall support button functions to bring up menus or to toggle to:

1. Select control mode for the LCS.
2. Advance to next page of vehicle record display.
3. Select main menu for other computer operation.

Violations shall be highlighted in the vehicle record display.

The WIM Computer shall buffer vehicle records for display purposes. The buffer shall represent multiple pages of windowing display.

The WIM Computer shall have application programs to detect prolonged power failure conditions to initiate orderly shut down operation of the Mainline Sorter System.

The WIM Computer shall have application programs to generate the following reports:

1. Number of vehicles per lane by class and by hour for a selected period.
2. Number of vehicles per lane by speed range for a class for a selected period.
3. Number of vehicles per lane by speed range and by hour for a selected period.
4. Axle and GVW weights by class for a selected period.
5. Number of vehicles per lane by weights, by class and by hour for a selected period.

A selected period for report generation shall include starting date and time and ending date and time. Reports shall be generated manually by operator action.

The WIM Computer shall have utility programs to list vehicle record files, transfer vehicle record files, sort vehicle record files and purge vehicle record files. Vehicle record files may be purged manually by operator action or automatically upon expiration of a preset archival period. Only those expired records shall be automatically purged.

The WIM Computer shall provide a manual console. The manual console shall provide the facility for an operator in a weigh station to select the control operation of the Mainline and Ramp LCS manually. The manual console shall provide two switch selectable functions:

- a. Select automatic control of the LCS by the mainline WIM system or the manual control of the LCS by the operator.
- b. In manual control mode of the LCS by an operator, set the LCS to direct all mainline traffic to enter Select or bypass the weigh station.

The manual console shall have visual indicators to identify the mode of control of the LCS.

The override signal control console will be located adjacent to the scale house display. It will provide the ability for the operator to manually override the directional signals. Vehicle movement information will be displayed using LED indicators on a graphical panel representing the overhead layout of the station. The LEDs will activate when the appropriate sensor is activated. In addition, the layout display will have LEDs representing the color and status of the directional signals. The LEDs will continuously display the status of the overhead signals.

The Override Signal Control Console must be operational independent of the weigh-in-motion interface electronics, to control all directional lights, i.e., the override console shall remain operational even if the sorter computer is not functioning.

5 Virtual WIM System Functional Requirements

5.1 WIM Scales

The accuracy of the Virtual WIM system will be in conformance with ASTM E 1318 “Standard Specifications for Highway Weigh-in-Motion (WIM) Systems with User Requirements and Test Method” performance requirements for a Type I system.

Prior to starting work on the CTH ‘N’ Virtual WIM site, the contractor shall obtain a permit to work on county trunk highway right-of-way. The contractor shall prepare and submit the form “Permit To Work in County Trunk Highway Right-Of-Way” to Dane County Highway and Transportation Department for approval and issuance of the permit.

The contractor shall replace the replace asphalt pavement at the CTH ‘N’ Virtual WIM site with Concrete Pavement Fast Track 11-Inches. The concrete pavement shall cover the entire width of the roadway, with doweled, 15-foot joint spacings. The concrete pavement shall begin 200 feet prior to the proposed southbound scale location and shall end 100 feet after, for a total of 300 feet of concrete roadway. The contractor shall blanket grind the complete length of the concrete with a minimum 36-inch blanket grinder.

The contractor shall grind the concrete roadway beginning 200 feet prior to the scale location and ending 100 feet after the scale location, for a total of 300 feet, with a minimum 36-inch blanket grinder to ensure that the roadway meets the requirements of Section 6 of ASTM E 1318-02.

Construction time, and the total lane closure time, shall not exceed past 14 hours per duration (consecutive closure time), including the time required for grinding and scale installation, but excluding the time required to construct the concrete pad.

The WIM scales shall be constructed of two independent weighing platforms placed across a roadway. The WIM scales shall measure approximately 144-inches x 38-inches including frame.

Each scale module shall be a self-contained weighing unit. Each scale module shall measure approximately 72-inches x 38-inches including frame.

The WIM scales shall operate properly in a temperature range of -40°F to +160°F. The WIM scales shall be weather-sealed. The WIM scales and their frames shall be rust proofed. All installation hardware shall be either stainless steel or rust proofed.

There shall be two scale frames into which the two scale modules are mounted. The WIM scale shall be installed flush with the road surface.

The WIM scales and frames shall be grounded as per manufacturer's recommendations. The signal processing electronic components/modules shall be protected against lightning.

5.2 Axle Sensors

The Virtual WIM system may use axle sensors in each lane for WIM or classification operation. If used, the axle sensors shall be Class I piezoelectric and approximately 12 feet in length.

The axle sensors shall be installed below the road surface. The axle sensors and their electrical wiring connector shall be completely water tight and sealed.

5.3 Loop Detectors

Each detector loop shall have a minimum loop area of 6-ft x 6-ft with 45° angle cuts at the corners. Detector loops shall conform to the standard specifications.

Loop wire must be 1 conductor, 14 AWG, IMSA 51-5. Loop leads must be 2 conductor, 14 gauge, IMSA 50-2 cable.

All saw-cut loops shall be sealed with 3M loop sealant.

5.4 System Electronics

The System Electronics shall be located next to the Virtual WIM scales in a roadside cabinet. The System Electronics shall be responsible for creating truck data and formatting the truck data for a web server to enable an enforcement officer to remotely view the vehicle records via wireless Ethernet. The WIM interface and Data Collection Computer will be a stand-alone system with the capability to collect and interpret the signals from the WIM Scale.

The Virtual WIM System Electronics shall contain the interface and signal conditioning for the inroad sensors and camera, a process computer, and an integral power supply within a single chassis. All material necessary for setup and operation of the system shall be provided including all cords and cabling. The system shall be provided with the required software pre-loaded so that it will automatically execute when the system is powered up.

The electronics shall be modular in design to facilitate easy maintenance, troubleshooting and in-field servicing. The computer, power supply and the interface electronics shall meet the following requirements.

The electronics shall include interfaces to the following components:

1. WIM Scales
2. Axle Sensing
3. Loops
4. Offscale Detection.
5. Camera System
6. Communications System

The roadside electronics shall provide a facility for viewing vehicle records and sensor diagnostics directly without any ancillary equipment.

All components of the electronic system, including inductive loop detectors, shall contain electrical protection to prevent damage from electrical surges, spikes and lightning.

The system shall be of a durable, industrial design and construction, and enable continuous operation, with automated start-up in the event of a power outage.

The System Electronics shall provide the following functions:

1. Perform WIM operation.
2. Match all violators bypassing the weigh station.
3. Weigh all vehicles traveling over WIM scales.
4. Classify all vehicles traveling on all instrumented lanes of the highway.
5. Perform weight compliance analysis on vehicles in accordance with department or agency regulations.
6. Perform sorter operation in accordance with decisions based on weight compliance analysis, other violations (speeding, improper maneuver, sudden speed change, etc.).
7. Insert sequence numbers for vehicle records for tracking purposes.
8. Capture images for all vehicles.
9. Filter out all non-interesting images and format for Web server.
10. Perform data collection, data storage, file management and report generation functions for collected vehicle information

The system shall include a data extraction system to allow data to be retrieved in the field.

The Virtual WIM system shall be provided with a roadside cabinet to house the System Electronics, the WIM computer and its peripherals and the overview camera equipment.

The roadside cabinet shall be lined and insulated and installed with a fan. All cutouts and openings shall be vermin proofed.

All wires from scales, offscale sensors, axle sensors, loops, cameras, shall be terminated on terminal strips or screw terminal connectors. The terminal strips shall be identified by terminal strip number and screw connection number. These terminal strips shall be readily accessible. All cables shall be long enough to easily reach these terminal strips. Terminal strips, splices, or other type of connections prior to these standard terminal strips shall not be allowed except for splicing of a loop to a shielded twisted loop lead.

All AC power connections shall be shielded to prevent electrical shock.

5.5 Camera System

The Camera System shall consist of the following system components:

1. Color and Black/White video camera
2. Illuminator system
3. Video capture system

The video system shall monitor traffic flow on the roadway at the Virtual WIM site. It shall capture still images of trucks having violations for identification and enforcement purposes. The images shall be displayed on an operator interface located in the scale house. Each vehicle record number shall be displayed with the vehicle image.

One camera shall be provided and installed on a pole located near the Virtual WIM location. The camera shall provide overview images of the passing commercial vehicles, detailing their cab and side. Color images shall be provided for daylight use, and black/white images shall be provided for night use.

The video capture system shall be located in one of the System Electronics. The video capture system shall provide control and display facility to display video outputs from one source to one monitor.

5.6 Communications

Data from the Virtual WIM System shall be communicated to the scale house via high-speed internet connection. The System shall allow the operator to dial in remotely for access to the vehicle data.

6 Conduits and Pull Boxes

All cables shall be in conduits unless specifically approved by the engineer. All pull boxes shall meet the standard specifications.

All materials shall comply with the "National Electrical Code" and the current standard specifications, "Highway Division Standard Drawings for design and Construction", and special requirements by State weigh in motion and automatic vehicle identification system specifications. Duct seal shall be used to seal all conduits in the cabinets and in all junction boxes. All conduits shall have a polyethylene pull string with at least 210-pound break strength left in place at completion of construction.

Separate conduits shall be used for AC/DC power and low voltage signal cables. Low voltage signal cables shall include video, digital communication, sensor signal cable, and sensor excitation cables where voltage is under +/- 20 volts DC. Conduits for video and RF cables shall be of a large enough size to accommodate the maximum bend radius using factory 90-degree "bends".

All cables shall be in conduits unless specifically approved by the department.

7 System Acceptance

The Mainline, Ramp and Virtual WIM Systems shall be accepted subject to fulfilling the following conditions:

1. System review
2. Acceptance tests (meeting WIM accuracy on a weekly basis).
3. Training

7.1 System Review

The selected WIM Vendor shall submit six (6) copies of a system layout for each individual site. These layouts shall be submitted to the department for review. Approval shall be either an official from the department or a designate.

A preliminary on-site meeting shall be held for each site to discuss contractors' plans for the routing of conduits, cables, and placement of equipment.

7.2 Acceptance Tests

The Mainline, Ramp and Virtual WIM Systems, all inclusive as contracted, shall be designed, built and tested by the Vendor, and as proof of operation, the systems, overall and singularly, shall be tested at various times according to the test specifications. All field tests shall be performed by the WIM Vendor and observed by the department with all reports submitted to the department.

7.2.1 Factory Acceptance Tests

Prior to shipment of any equipment, Factory Acceptance Tests shall be performed for each system to verify the equipment operating as described in the contract documents and in accordance with the test specifications approved by the department. The Factory Acceptance Tests shall include at minimum the following:

1. A physical inspection to verify that the quality of material and workmanship satisfy specified requirements and standards and that the equipment and software under test are complete and ready for delivery.

2. A functional test to verify that the equipment and software operate as described in the contract documents.
3. A performance test to verify that the equipment satisfies performance and operation criteria.

For the purpose of these tests the equipment and software shall be configured as nearly as possible to the final configuration. Any field inputs not available at the factory test site shall be simulated to provide a close approximation to actual site conditions.

7.2.2 Site Acceptance Tests

After all the equipment and software have been installed at the site, the Vendor shall run tests to ensure that all equipment shall operate as specified therein contract documents. These tests shall be witnessed or conducted by the department within one week of the manufacturer notifying the department that the system is ready for testing.

7.2.3 Continuous Operating Test

Following successful completion of the Site Acceptance Test, a Continuous Operating Test shall be conducted for a period of fifty-six (56) calendar days. During this period the weigh station and its Weight Sorter System shall operate under normal conditions and attain a Level of Service of 98.0% or better of the total station operating hours within any period of 56 consecutive days.

The Weight Sorter System shall be considered unavailable when:

1. A major system component completely fails which significantly degrade the performance or operation of the weigh station. This situation is said to have prevailed if either the WIM system or the communication system has failed.
2. More than one system component fails to operate or respond to operator commands and/or system automation for more than thirty minutes.
3. Weekly WIM accuracy is not met.

During the continuous operating test, the entire Mainline, Ramp and Virtual WIM Systems shall be fully operational under normal traffic conditions and operate trouble free for 56 consecutive days. During the continuous operating test the WIM accuracy test/database shall be printed by department personnel and met weekly as previously specified for the Mainline, Ramp and Virtual WIM Systems.

In the event the one of the above mentioned conditions persists and the specified availability cannot be achieved, the WIM Vendor will be informed and problem(s) shall be corrected and the continuous operating test shall start over until 56 continuous days of trouble free operation are experienced. This re-start can only occur three times. In order for this test to be valid, the static scale must be fully operational for the 56-day period. The WIM Vendor must leave the site prior to the start of the continuous test and may only return if a problem is encountered or accompanied by the engineer.

Payment:

1. Payment upon safe and secure delivery of all equipment at a storage location approved by the engineer	50%
2. Complete installation of the entire SYSTEM	20%
3. Completion of calibration and burn-in	5%
4. Completion of the APT to the satisfaction of the engineer	25%

The continuous operating test will be the basis for acceptance or rejection of the systems (mainline, ramp and virtual) as a result of demonstrated performance. If the SYSTEM is rejected and there have been more than three strikes and re-starts of the APT, the parties will negotiate, in good faith, an acceptable resolution. Following such negotiations, if the same are unsuccessful, the department may execute the performance bond. Notwithstanding the foregoing, the contractor will retain/be entitled to receive all amounts paid or payable to the contractor in accordance with the above payment schedule, agreed-to by the parties:

The department shall issue a Certificate of Final Acceptance upon successful completion of the Continuous Operating Test and training program.

This calibration/acceptance procedure follows latest version ASTM E1318 Standards. Calibration is to be performed by the running of one (1) calibration truck. The five (5) axle, test vehicle should be of a tractor/trailer combination (3S2), complete with air ride suspension and a non-shifting static load. The truck will be loaded to within 90 to 100% of allowable Gross Vehicle Weight for the road under test. The truck will be in excellent mechanical condition.

The calibration procedure is as follows:

1. The vehicle will be weighed at a government certified static weigh scale. The weight information on the front (single axle), drive (tandem axle group), and trailer (tandem axle group), should be recorded. The Gross Vehicle Weight (GVW) of the vehicle will be calculated by adding the three weights together.
2. The distance between the five (5) individual axles on the truck will be measured and recorded.
3. The test vehicle will make three (3) test passes over the system under test at a selected speed which is indicative of the truck traffic at the site. Adjustments will be made by vendor personnel on site during this time to fine tune the axle spacing, and weight output of the WIM system.
4. Once all initial adjustments have been made, the test vehicle will make an additional two (2) test passes to confirm the accuracy of the adjustments. If all the readings fall within the latest version ASTM ranges for the WIM Type under test, and vendor personnel do not feel that additional adjustments are required, the tests will continue. If this is not the case, additional adjustments will be performed and two (2) more confirming passes will be made by the test truck.

5. The test truck should then make an additional ten (10) passes at a selected speed that is indicative of the truck traffic at the test site.
6. All of the data should be recorded and placed into a spreadsheet.
7. The mean error and standard deviation for all recorded measurements will be calculated at the end of the ten (10) test passes. The calculations will be as follows:
 - A. For weight measurements, the percent error for each test pass will be calculated using the following formula:

$$[(\text{WIM Weight} - \text{Static Weight}) / \text{Static Weight}] \times 100 = \% \text{ error}$$
 - B. The mean error for each weight type (single, group, GVW) will be calculated as follows:

$$\% \text{ errors for single, group or GVW} / \# \text{ of samples} = \text{Mean error}$$
 (Each weight type calculated individually)
 - C. The error for individual axle spacings will be calculated using the following formula:

$$10 \text{ of } [(\text{WIM Axle Spacings} - \text{Actual Axle Spacing})] / 10 = \text{Mean Axle Spacing Error}$$
 (Each of the four axle spacings calculated individually)
8. All of the calculated errors will also be entered into the spreadsheet.
9. A check will be made of the calculated result against the acceptable range for the latest version ASTM WIM Type under test. There will be one of two results:
 - A. If 95% of all recorded test results, (single axles, axle groups, GVW, axle spacing) fall within the specified tolerance for the latest version ASTM WIM Type under test then the system will have passed the requirements.
 - B. If less than 95% of the calculated differences fall within the specified tolerance for the latest version ASTM WIM Type under test then the system will be readjusted and an additional ten (10) test passes will be required to retest the system.
10. The testing will continue until the system passes all criteria according to latest version ASTM E1318 Standards.

8 Training

The vendor shall set up and conduct formal training programs for the State Patrol personnel on the operation, maintenance and installation of the system components of the Mainline, Ramp and Virtual WIM Systems. The training shall include the following:

1. Two half-day operator training sessions providing an introduction to the operation and installation of the Mainline, Ramp and Virtual WIM Systems, and to the functions performed by the major system components. A class size of up to eight individuals per session can be expected.

2. Two one-day "hands-on" guidance sessions for operators in the operation of the systems. A class size of up to four individuals per session can be expected. This training will occur during the first two days of the Continuous Operating Test.

The training program will be scheduled the week following the completion of the operations test.

The cost for the first training sessions shall be included in the contract price. The department will, from time to time review any future training requirements. The WIM vendor shall agree to provide future and additional training sessions upon receipt of requests from department. The department shall reimburse the WIM vendor the cost of providing additional training sessions on a per diem basis and at a rate agreed upon by the department at the time of the request. The department will provide classroom space for training session.

9 Warranty

The WIM Vendor shall warrant all subsystems and system components as supplied for ten (10) years from the date of issuance of the Certificate of Final Acceptance of the Mainline, Ramp and Virtual WIM Systems by the engineer.

The warranty shall cover all system components, hardware and software, included in the contract for any defects in material and workmanship. This shall include:

- All loops, WIM Scales, off scale sensors and piezoelectric sensors on site.
- Interface operations, system electronics and housing cabinet.
- WIM cables, connectors, terminal strips and back-up batteries.
- Notification signs.
- Structures.
- Communication systems.
- Camera and video equipment and technology.

The warranty agreement shall include:

- Routine maintenance service scheduled at 6-month intervals,
- Emergency repair service, and
- Operator refresher courses.

The weight sorter equipment shall be warranted by the WIM Vendor, in writing, against defects in or from material, workmanship, lightning, and to perform as required by these technical special provisions, giving proper and continuous service under all conditions required and specified, or which may reasonably be inferred, for a period of ten (10) years from the date of acceptance. The Vendor shall furnish the written Vendor's warranty to the department at the time the equipment performance supporting data is submitted. The ramp sorter equipment weighing instruments, load cells, weigh bridge, hardware, and software shall be warranted by the manufacturer, in writing, against defects in or from material, workmanship, lightning, and perform as required by these technical special provisions for the period of ten (10) years or as described above from the date of final acceptance of the project.

The operation and maintenance of all AVI equipment, as well as all AVI-related subsystems, shall be warranted by PrePass. This equipment will not be included within the scope of the warranty as seen in this specification.

9.1 Scheduled Maintenance Service

The Vendor's routine maintenance on all major systems, system components and ancillary equipment shall be scheduled at 6-month intervals. A semi-annual maintenance report shall be submitted to the department upon completion of the scheduled maintenance service. Scheduled maintenance, emergency maintenance and refresher training (as required) shall be included as part of the ten (10) year warranty.

The scheduled maintenance service shall include the following:

1. Visual inspection, signal checks and testing measures on all loops;
2. Cleaning, repair and testing measures on all WIM Scales (Mainline and Ramp), WIM Scales (Virtual WIM System);
3. Visual inspection and testing measures on all offscale sensors;
4. Visual inspection, testing measures and signal checks on all piezoelectric sensors;
5. Visual inspection and cleaning of cabinet and system electronics;
6. Maintenance of WIM cables, connectors, terminal strips and back-up batteries;
7. Electrical inspection;
8. Cabinet mechanical condition inspection;
9. Heating, ventilation and air conditioning maintenance;
10. Interface card operation inspection, testing measures and maintenance;
11. Notification sign inspection, testing and maintenance;
12. Structural integrity check of all poles and mast arms;
13. Inspection and verification of computer communication systems; and
14. Camera and Video inspection, testing and maintenance.

A report shall accompany the scheduled maintenance service and shall be submitted to the department. The report shall include:

1. Pass/Fail grading of all loops, scales, offscale sensors and piezoelectric sensors;
2. A checklist of all components checked as listed above, as well as the location of the components and comments on their general state; and
3. A checklist and commentary detailing whether each component (as listed above) met standards or required repairs.

9.2 Emergency Repair Services

Emergency repair services shall be completed on an as-required basis. The maximum response time for emergency repair services shall not exceed 72 hours after written receipt of notice by fax. The vendor shall initiate on-site repairs within 7 days of notification.

9.3 Operator Refresher Courses

In conjunction with the scheduled maintenance services, the vendor shall provide Operator Refresher Courses on the operation of the entire Mainline, Ramp and Virtual

WIM system. The courses shall have a maximum duration of four (4) hours and shall be scheduled before or after the semi-annual maintenance service. The course attendees shall be decided by the department.

10 Materials

Material used in the construction of this equipment shall be of good commercial quality entirely suitable for the intended purpose. Material shall be free from all defects and imperfections that might affect serviceability of the finished product.

11 Standard Products

The equipment shall be constructed of standard material, so that the prompt and continuing service and delivery of spare parts may be assured. The component parts need not be products of the same manufacturer.

12 Lightning Protection

Ground rod (s) and lightning protection shall be provided as per manufacturer's requirements. All system components and equipment shall be properly grounded.

13 Measurement

The department will measure Weigh-In-Motion System, completed and accepted in accordance with the terms of the contract, as a single complete unit of work.

14 Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.08	Weigh-In-Motion System	LS

Payment is full compensation for furnishing and installing all material and all utility hook-ups; performing all pavement grinding; and for furnishing all labor, supervision, equipment, calibrating and testing, warranties, training, tools and incidentals necessary to complete the contracted work. Materials and equipment included in the Weigh-In-Motion System are a mainline WIM, ramp WIM, USH 51 virtual WIM, CTH N virtual WIM, concrete control pad, Load Cell Scale, Piezoelectric Sensor, System Electronics (including all interface cards), WIM cabinet, Uninterrupted Power Supply, Modem, X-terminal, Manual Console, Printer, cabling, conduit, junction boxes, software, software licenses, Lane Control Signals, "Open/Closed" inserts and Dual Message Signs.

Sawing Existing Pavement, Sawing Concrete Pavement Full Depth, Removing Pavement, Pavement Dowel Bars, Pavement Ties, Concrete Pavement Fast Track 11-Inch, Pavement Marking, Steel Plate Beam Guard and Steel Plate Beam Guard Energy Absorbing Terminal will be paid under separate bid items.

ASTM E 1318-02 For Weigh-In-Motion System.

See following pages:



Standard Specification for Highway Weigh-In-Motion (WIM) Systems with User Requirements and Test Methods¹

This standard is issued under the fixed designation E 1318; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 *Weigh-In-Motion*—This specification describes Weigh-In-Motion (WIM), the process of measuring the dynamic tire forces of a moving vehicle and estimating the corresponding tire loads of the static vehicle. Gross-vehicle weight of a highway vehicle is due only to the local force of gravity acting upon the composite mass of all connected vehicle components, and is distributed among the tires of the vehicle through connectors such as springs, motion dampers, and hinges. Highway WIM systems are capable of estimating the gross weight of a vehicle as well as the portion of this weight, called load in this specification, that is carried by the tires of each wheel assembly, axle, and axle group on the vehicle.

1.2 *Other Traffic Data*—Ancillary traffic data concerning the speed, lane of operation, date and time of passage, number and spacing of axles, and classification (according to axle arrangement) of each vehicle that is weighed in motion is desired for certain purposes. It is feasible for a WIM system to measure or calculate these traffic parameters and to process, summarize, store, display, record, hard-copy, and transmit the resulting data. Furthermore, differences in measured or calculated parameters as compared with selected control criteria can be detected and indicated to aid enforcement. In addition to tire-load information, a WIM system is capable of producing all, or specified portions of, these traffic data.

1.3 *Standard Specification*—Highway WIM systems generally have three applications: collecting statistical traffic data, aiding enforcement, and enforcement. This specification classifies four types of WIM systems according to their application and details their respective functional, performance, and user requirements. It is a performance-type (end product-type) specification. Exceptions and options to the specification may be included in any specification prepared by the user as part of the procurement process for WIM equipment or services, and vendors may offer exceptions and options in responding to an invitation to bid.

1.4 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are

mathematical conversions to SI units² which are provided for information only and are not considered standard.

1.5 The following precautionary caveat applies only to the test method portion, Section 7, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

E 867 Terminology Relating to Vehicle-Pavement Systems³

2.2 AASHTO Standards:

AASHTO Interim Guide for Design of Pavement Structures—1972, 1981⁴

AASHTO Guide for Design of Pavement Structures—1986, 1993⁴

3. Terminology

3.1 Definitions:

3.1.1 *weigh-in-motion (WIM), n*—the process of estimating a moving vehicle's gross weight and the portion of that weight that is carried by each wheel, axle, or axle group, or combination thereof, by measurement and analysis of dynamic vehicle tire forces. (See Terminology E 867)

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *accuracy, n*—the closeness or degree of agreement (within a stated tolerance and probability of conformity) between a value measured or estimated by a WIM system and an accepted reference value.

3.2.2 *axle, n*—the axis oriented transversely to the nominal direction of vehicle motion, and extending the full width of the vehicle, about which the wheel(s) at both ends rotate.

3.2.3 *axle-group load, [lb (kg)], n*—the sum of all tire loads

¹ This specification is under the jurisdiction of ASTM Committee E17 on Vehicle-Pavement Systems and is the direct responsibility of Subcommittee E17.52 on Traffic Monitoring.

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² Standard Practice for Use of the International System of Units (SI): The Modern Metric System, IEEE/ASTM SI 10-1997, The Institute of Electrical and Electronics Engineers, Inc., 1828 L. St. NW, Suite 1202, Washington, DC 20036-5101, USA, and ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA, ISBN 1-55937-901-4.

³ *Annual Book of ASTM Standards*, Vol 04.03.

⁴ Available from American Association of State Highway and Transportation Officials, 444 N. Capitol St., NW, Suite 249, Washington, DC 20001.

of the wheels on a group of adjacent axles; a portion of the gross-vehicle weight.

3.2.3.1 *Discussion*—An axle group can be defined in terms of the number of axles included in the group and their respective interspaces.

3.2.4 *axle load* [*lb (kg)*], *n*—the sum of all tire loads of the wheels on an axle; a portion of the gross-vehicle weight.

3.2.5 *dynamic vehicle tire force*, [*lb (kg)*], *n*—the component of the time-varying force applied perpendicularly to the road surface by the tire of a moving vehicle.

3.2.5.1 *Discussion*—In addition to the force of gravity, this force can include the dynamic effects of influences such as road surface roughness, vehicle acceleration, out-of-round tires, dynamically-unbalanced wheels, tire inflation pressure, vehicle suspension and aerodynamic features, and wind. For purposes of this specification, the WIM System shall be adjusted or calibrated to indicate the magnitude of the measured dynamic vehicle tire force in units of mass, lb (kg). (See 3.2.13.1).

3.2.6 *gross-vehicle weight*, [*lb (kg)*], *n*—the total weight of the vehicle or the vehicle combination including all connected components; also, the sum of the tire loads of all wheels on the vehicle. (See 3.2.13.1).

3.2.7 *single-axle load*, [*lb (kg)*], *n*—the load transmitted to the road surface by the tires of all wheels lying between two parallel transverse vertical planes 3.3 ft (1 m) apart, extending across the full width of the vehicle; a portion of the gross-vehicle weight.

3.2.8 *tandem-axle load*, [*lb (kg)*], *n*—the total load transmitted to the road surface by the tires on all wheels of two consecutive vehicle axles that are more than 3.3 ft (1 m) and not more than 8 ft (2.4 m) apart; a portion of the gross-vehicle weight.

3.2.9 *tire load*, [*lb (kg)*], *n*—the portion of the gross-vehicle weight imposed upon the static tire at the time of weighing, expressed in units of mass, due only to the vertically-downward force of gravity acting on the total mass of the static vehicle.

3.2.10 *tolerance*, *n*—the defined limit of allowable departure of a value measured or estimated by a WIM system from an accepted reference value.

3.2.11 *triple-axle load*, [*lb (kg)*], *n*—the total load transmitted to the road surface by the tires on all wheels of three consecutive vehicle axles, with not more than 12 ft (3.7 m) between the two axles furthest apart; a portion of the gross-vehicle weight.

3.2.12 *weigh*, *v tr*—to measure the tire load on one or more tires by using a vehicle scale, an axle-load scale, a portable axle-load weigher, or a wheel-load weigher.

3.2.12.1 *Discussion*—Refer to Sec. 2.20, of *National Institute of Standards and Technology (NIST) Handbook 44* (1)⁵ for a definition of each type of weighing device. These devices are usually subjected to field standard test weights at each locality of use and are adjusted to indicate units of mass (See Sec. 3.2, Appendix B, *NIST Handbook 44*).

3.2.13 *weight*, [*lb (kg)*], *n*—the external force of gravity acting vertically downwards upon a body with a magnitude

equal to the body's mass multiplied by the local acceleration of free fall.²

3.2.13.1 *Discussion*—The force of gravity—thus, the acceleration of free fall—is different at various locations on or near the surface of Earth; therefore, weighing devices in commercial use or in official use by government agencies for enforcement of traffic and highway laws or collecting statistical information are usually used in one locality and are adjusted or calibrated to indicate mass at that locality. (1) The indicated mass can be converted to weight (in units of force) by multiplying by the local value of the acceleration of free fall, if it is known. The conventional value adopted by ISO is 32.174 049 ft/s² (9.806 65 m/s²). Weight is a special case of force, as weight is due only to the local force of gravity, that is always directed vertically downwards. For purposes of this specification, and in accordance with common weighing practice, the WIM System shall be adjusted or calibrated to indicate the magnitude of estimated weight and load in units of mass, pounds [avoirdupois] (kilograms), and the direction of the associated force vector will always be downwards toward the approximate center of Earth.

3.2.14 *wheel load*, [*lb (kg)*], *n*—the sum of the tire loads on all tires included in the wheel assembly on one end of an axle; a wheel assembly may have a single tire or dual tires.

3.2.15 *WIM System*, *n*—a set of sensors and supporting instruments that measure the presence of a moving vehicle and the related dynamic tire forces at specified locations with respect to time; estimate tire loads; calculate speed, axle spacing, vehicle class according to axle arrangement, and other parameters concerning the vehicle; and process, display, store, and transmit this information. This standard applies only to highway vehicles.

4. Classification

4.1 *Types*—WIM systems shall be specified to meet the needs of the user for intended applications in accordance with the following types. Exceptions and options may be specified (See 1.3). All systems shall be designed to operate with the local electrical power of the country (that is, 110V, ac, 60-Hz power in North America). Lightning protection for affected system components shall be provided by the vendor. The user may specify as options a completely battery-powered system or battery-backup power in case of failure of normal power. All systems shall allow the user to select at the beginning of each data-taking session the units of measurement: either U.S. customary units or SI units². The units setting shall remain where last assigned unless changed by the user at the beginning of a data-taking session. Load and weight values shall be expressed in units of mass: pounds [avoirdupois] in U.S. customary units, or kilograms in SI units. The SI recommends expressing large values of mass in megagrams, Mg. In commercial usage, which includes most applications and interpretations of WIM data, 1 Mg = 1000 kg = 1 metric ton = 1 tonne.

4.1.1 *Type I*—This type of WIM system shall be designed for installation in one or more lanes at a traffic data-collection site and shall be capable of accommodating highway vehicles moving at speeds from 10 to 80 mph (16 to 130 km/h), inclusive. For each vehicle processed, the system shall produce all data items shown in Table 1. A user-controlled feature of the

⁵ The boldface numbers given in parentheses refer to a list of references at the end of the text.

TABLE 1 Data Items Produced by WIM System

1.	Wheel Load
2.	Axle Load
3.	Axle-Group Load
4.	Gross-Vehicle Weight
5.	Speed
6.	Center-to-Center Spacing Between Axes
7.	Vehicle Class (via axle arrangement)
8.	Site Identification Code
9.	Lane and Direction of Travel
10.	Date and Time of Passage
11.	Sequential Vehicle Record Number
12.	Wheelbase (front-most to rear-most axle)
13.	Equivalent Single-Axle Loads (ESALs)
14.	Violation Code

system shall allow tire-force information from the wheel(s) on only one end of an axle to be used to estimate axle load. Provisions shall be made for entering selected limits and tolerances for wheel, axle, axle-group (including bridge-formula grouping (2)) loads, and gross-vehicle weights as well as speed, and for detecting and indicating suspected violation of any of these limits by a particular vehicle. A feature shall be provided so that the user can determine whether or not the WIM system will prepare selected data items for display and recording. Use of this feature shall not inhibit the system from receiving and processing data. Data shall be processed on-site in such a way that all data items shown in Table 1 can be displayed in alphanumeric form for immediate review. This may be accomplished by connecting a portable (for example, laptop) computer, furnished and supported by the vendor as a part of the WIM-system equipment, directly to the on-site instruments. Means shall be provided for temporary, on-site storage of data items 1, 5, 6, 8, 9, 10, and 11 for each vehicle processed by the WIM system, or for only those vehicles with a front-axle or front-wheel load that exceeds a value set into the on-site system by the user at the beginning of a data-taking session. Also, means shall be provided for rapid, efficient transfer of these data to files made available on a compatible host computer (furnished by either the user or the vendor, as specified for the specific site by the user) at a remote location according to an appropriate time schedule and data format specified by the user. The vendor shall furnish, document, and support software for use on the host computer for processing the transferred data items in such a way that all data items shown in Table 1 can be displayed in alphanumeric form for immediate review and subsequent use by the host computer user. This same software shall be provided on the portable computer for use when it is connected directly to the on-site instruments. On-site presentation of a hard-copy of all data items produced by the system shall be an optional feature (Option 1) of the system. Option 2 for this type of WIM system shall additionally provide means for counting and for recording hourly the lane-wise count of all vehicles traveling in each lane, up to a maximum of ten lanes, at a data-collection site, including lanes without WIM sensors. Option 3 shall provide for counting, classifying (via axle arrangement), measuring the speed of, and recording the hourly totals concerning all such vehicles by class (according to axle arrangement) and by lane of travel.

4.1.2 Type II—This type of WIM system shall be designed for installation in one or more lanes at traffic data-collection

sites and should be capable of accommodating highway vehicles moving at speeds from 15 to 80 mph (24 to 130 km/h), inclusive. For each vehicle processed, all data items shown in Table 1 except Item 1 shall be produced by the system. All other features and options of the Type II WIM system shall be identical to those described in 4.1.1 for the Type I WIM system.

4.1.3 Type III—This type of WIM system shall be designed with sensors installed in one or more lanes off the main highway lanes at weight-enforcement stations, or in one or more main highway lanes, to identify vehicles operating at speeds from 10 to 80 mph (16 to 130 km/h), inclusive, that are suspected of weight-limit or load-limit violation. When the sensors are installed in the main highway lane(s), the Type III system will not be required to measure vehicle acceleration. For each vehicle processed, the system shall produce all data items shown in Table 1 except 7, 12, and 13 and shall also estimate acceleration (while the vehicle is over the WIM-system sensors). Provisions shall be made for entering selected limits for wheel, axle, axle-group (including bridge-formula grouping (2)) loads, and gross-vehicle weight as well as speed and acceleration, and for detecting and indicating suspected violation of any of these limits by a particular vehicle. Means shall be provided for automatically controlling official traffic-control devices that will direct each suspect vehicle to a scale for confirmation weighing and guide all non-suspect vehicles past the scale without stopping. Manual operation of these official traffic-control devices shall be included as a feature of the Type III WIM system. Information used in determining a suspected violation shall be displayed in alphanumeric form for immediate review and recorded permanently. Option 1 shall provide means for presenting this information in hard-copy form if requested by the system operator. Option 2 may be specified to exempt the Type III WIM system from producing wheel-load information (Item 1 in Table 1) if this data item is not of interest for enforcement. Option 3 for this type of WIM system shall provide for recording the following data items shown in Table 1 for every vehicle processed by the system: 1 (2 in lieu of 1 when Option 2 is specified), 5, 6, 8, 9, 10, and 11. These basic-data items allow subsequent computation of statistical traffic data.

4.1.4 Type IV—This type of WIM system has not yet been approved for use in the United States, but for conceptual development purposes, it shall be designed for use at weight-enforcement stations to detect weight-limit or load-limit violations. Speeds from 2 to 10 mph (3 to 16 km/h), inclusive, shall be accommodated. A Type IV system that uses tire-force sensors (see 5.13) that support the entire tire-contact area(s) of all tires on a wheel assembly simultaneously shall also be capable of indicating the wheel load(s), if applicable, and individual axle loads for a stationary vehicle. For each vehicle that is processed, the system shall produce all data items shown in Table 1 except 7, 9, 12, and 13 and shall also estimate acceleration (while the vehicle is over the WIM-system sensors). Provisions shall be made for entering and displaying selected limits for wheel, axle, axle-group (including bridge-formula grouping (2)) loads, and gross-vehicle weights as well as speed and acceleration, and for detecting and indicating

violation of any of these limits by a particular vehicle. Information used in determining a violation shall be displayed in alphanumeric form for immediate review and recorded permanently. Option 1 shall provide means for presenting this information in hard-copy form if requested by the system operator. Option 2 may be specified to exempt the Type IV WIM system from producing wheel-load information (Item 1 in Table 1) if this data item is not of interest for enforcement.

5. Performance Requirements

5.1 Accuracy—Each type of WIM system shall be capable of performing the indicated functions within the accuracy shown in Table 2. A test method for determining compliance with these requirements under prevailing site conditions is given in Section 7. The stated accuracy should be maintained for ambient air temperatures at the WIM site from -20 to 120°F (-28 to 50°C); however, the user shall specify at the time of system procurement the range of temperatures within which the WIM system must operate properly. The vendor shall supply evidence that the system offered is capable of compliance. After computation of the data items shown in Table 2, no digit that indicates less than 100 lb (50 kg) (load or weight), 1 mph (2 km/h) (speed), or 0.1 ft (0.03 m) (axle spacing) shall be retained.

5.2 Vehicle Class—Vehicle classification according to axle arrangement shall be accomplished by Type I and Type II WIM systems. The vendor shall incorporate software within each Type I and Type II WIM system for using the available WIM-system axle-count and axle-spacing information for estimating the Federal Highway Administration (FHWA) Vehicle Types described briefly in Table 3. See *U.S. Department of Transportation Traffic Monitoring Guide* (2) for the complete description of FHWA Vehicle Types. The axle-spacing values used for this process shall be associated with each vehicle classified via the software. The values shall be made readily accessible to the user, and a means shall be provided for the user to modify the values easily. The FHWA Vehicle Type shall be indicated by the 2-Digit Code shown in Table 3. A user-defined Vehicle Type Code 14 shall be provided for application by the user. A Vehicle Type Code 15 shall be applied to any vehicle that the software fails to assign to one of the types described.

5.3 Site Identification Code—Provisions shall be made in Type I, Type II, Type III, and Type IV WIM systems for entering, displaying, and recording a ten-character alphanumeric site identification code for each data-taking session. This code can be used to incorporate information required for FHWA Truck Weight Data Collection (2).

TABLE 3 FHWA Vehicle Types

2-Digit Code	Brief Description
01	Motorcycles
02	Passenger Cars
03	Other Two-Axle, Four-Tire Single Unit Vehicles
04	Buses
05	Two-Axle, Six-Tire, Single Unit Trucks
06	Three-Axle, Single Unit Trucks
07	Four-or-More Axle Single Unit Trucks
08	Four-or-Less Axle Single Trailer Trucks
09	Five-Axle Single Trailer Trucks
10	Six-or-More Axle Single Trailer Trucks
11	Five-or-Less Axle Multi-Trailer Trucks
12	Six-Axle Multi-Trailer Trucks
13	Seven-or-More Axle Multi-Trailer Trucks

5.4 Lane and Direction Code—A lane and direction-of-travel code for each vehicle processed by Type I, Type II, and Type III WIM systems shall consist of a number beginning with 1 for the right-hand northbound or eastbound traffic lane and continuing until all the lanes in that direction of travel have been numbered; the next sequential number shall be assigned to the lanes in the opposite direction of travel beginning with the left-hand lane and continuing until all lanes have been numbered. Provision shall be made for 12 numbers in the code. This code may be used to incorporate information required for FHWA Truck Weight Data Collection (2).

5.5 Date—Date of passage shall be indicated numerically in each vehicle record processed by Type I, Type II, Type III, and Type IV WIM systems. The date format(s) used by the WIM system to produce the vehicle record shall be clearly documented and defaulted to the generally accepted format in the country of use. In the United States, the MM/DD/YY format, where MM is the month, DD is the day, and YY is the year, is generally accepted.

5.6 Time—Time of passage shall be indicated numerically for each vehicle processed by Type I, Type II, Type III, and Type IV WIM systems in the following format: hh:mm:ss, where hh is the hour beginning with 00 at midnight and continuing through 23, mm is the minute, and ss is the second.

5.7 Vehicle Record Number—Type I, Type II, Type III, and Type IV WIM systems shall provide sequential-numbering (user-adjustable) for each recorded vehicular data set.

5.8 Wheelbase—Type I and Type II WIM systems shall compute wheelbase as the sum of all axle spacings between centers of the front-most and the rear-most axles on the vehicle or combination that have tires in contact with the road surface at the time of weighing. This value shall be rounded to an integer value (in feet) (or to the nearest 0.1 m) before display or recording.

TABLE 2 Functional Performance Requirements for WIM Systems

Function	Tolerance for 95 % Probability of Conformity				
	Type I	Type II	Type III	Type IV	
				Value $\pm$ lb (kg) ^A	$\pm$ lb (kg)
Wheel Load	± 25 %		± 20 %	5000 (2300)	300 (100)
Axle Load	± 20 %	± 30 %	± 15 %	12 000 (5400)	500 (200)
Axle-Group Load	± 15 %	± 20 %	± 10 %	25 000 (11 300)	1200 (500)
Gross-Vehicle Weight	± 10 %	± 15 %	± 6 %	60 000 (27 200)	2500 (1100)
Speed			± 1 mph (2 km/h)		
Axle-Spacing			± 0.5 ft (0.15 m)		

^A Lower values are not usually a concern in enforcement.

5.9 *ESALs*—Type I and Type II WIM systems shall compute Equivalent Single-Axle Loads (ESALs) using American Association of State Highway and Transportation Officials (AASHTO) axle load equivalence factors (see 2.2 and (3, 4, 6, 7)) for single, tandem, and triple axles for flexible or for rigid pavements. Provision shall be made for the user to select one of these pavement types for application at the beginning of any given data-processing session. The computations must be made using only U.S. customary units. The system shall compute the total ESALs for each vehicle or vehicle combination and prepare these data for display as part of each vehicle record. When displayed, this value shall be rounded to two significant digits following the decimal and presented in the following format: FESAL = for flexible pavements, and RESAL = for rigid pavements. The parameter for serviceability at the end of time t , p_r , shall be adjustable by the user, but 2.5 shall be programmed as a default value. Similarly, the value for structural number, SN , used for computing flexible pavement equivalence factors shall be user adjustable, but shall be defaulted to 5.0 (see 2.2). The value for thickness of rigid pavement slab, D , used in computing rigid pavement equivalence factors shall be user adjustable, and shall be defaulted to 9.0 in. (see 2.2) in the WIM-system program. Provision shall be made in the program to list on demand all parameters actually utilized in the ESAL computation during any given data-processing session. The user shall specify the method(s) (see 5.9.2 and 5.9.3) that will be provided by the vendor in the WIM-system software for applying LEFs to compute ESALs. Every Type I and Type II WIM system shall include software for performing the computation of ESALs by the method described in 5.9.3.

5.9.1 *Computation of LEFs*—Equations for calculating the AASHTO axle load equivalence factor (LEF) for each axle type (single, tandem, triple) and load are presented in Annex A1. These equations may be used to calculate directly the LEF for an individual axle load and type, terminal serviceability, and pavement strength characteristic (SN for flexible or D for rigid) in lieu of using the tabular (previously calculated from the equations for selected increments of the variables) values presented in the AASHTO pavement design guides (see 2.2). The equations were derived from statistical analysis of data taken during the AASHTO (now AASHTO) Road Test (3, 4); therefore, the applicability of the equations to model the relationship among the included variables is limited to the nature and range of each variable that was observed at the AASHTO Road Test. The axle load that was included as a variable in the derivation of the regression equations was only the load on axles of the test trucks that were called load axles. The observed change in pavement serviceability that resulted from the steering axle on each test truck, except pickup-type trucks, that was run at the AASHTO Road Test was not assessed separately, but was incorporated into that which was attributed in the regression equations to the loads on the other axles (single or tandem) on each test truck. The steering axle and the rear axle on pickup-type test trucks were both called load axles and provided data points for direct inclusion of the effects of 2000-lb single-tire, single-axle loads in developing the regression equations.

5.9.2 *Applying LEFs to Compute ESALs: Method Using AASHTO Road Test Concepts*—By AASHTO's concept, Equivalent Single Axle Loads (ESALs) are the cumulative number of applications of an 18 000-lb single-axle load (a common denominator) that will have an equivalent effect on pavement serviceability of a specified pavement structure as all applications of the axle loads on single, tandem, and triple axles on all vehicles in a defined mixed-traffic stream. AASHTO ESALs are determined by calculating the LEF for each axle set on all vehicles in a measured or assumed mixed-traffic stream according to its axle type (single, tandem, triple) and magnitude of load for a defined pavement structure and terminal serviceability, and summing the LEFs. Except for axle loads of 2000 lb or less on the axles of two-axle vehicles, the LEF calculated for a single axle is not applicable to the steering axle in calculating ESALs. The nominal values of steering axle loads at the AASHTO Road Test ranged from 2000 to 12 000 lb. Thus, no steering axle load exceeded 12 000 lb, nominal. So, for steering axles loaded to less than 12 000 lb (as at the AASHTO Road Test) no LEF should be applied to the steering-axle load; its effect has already been accounted for. But, for steering axles loaded to 12 000 lb or more (not used at the AASHTO Road Test), an appropriate, single-tire LEF should be applied, and these ESALs should be accumulated along with those from the other (non-steering) axle(s) on the vehicle. (7)

5.9.3 *Applying LEFs to Compute ESALs: Method Used for the Examples in AASHTO Guides*—The method that is illustrated by numerical examples shown in 2.2 for applying load equivalence factors in calculating ESALs have been followed by state agencies and FHWA since 1972. So that ESALs values comparable to those already on file will be produced by future WIM systems that comply with this specification, the illustrated methodology shall, as a minimum, be implemented in every such system. In the numerical examples in the guides, the steering axle is considered to be a "single" axle along with other single axles on a vehicle. In calculating the total ESALs for all vehicles in an observed or assumed mixed-traffic stream, for each vehicle class, the number of axles, according to axle type, in various load classes is listed, and then a tabular value (calculated from the regression equations by using the middle value in the load range) for the "Traffic Equivalency Factor" (called herein a Load Equivalence Factor, LEF) is multiplied by the number of observed axles, according to axle type, in each load class to yield the "A 18 Kip EAL's" (Average 18-Kip Equivalent Axle Loads) attributable to each axle type for all observed axles. The sum of the EALs for all observed axles is divided by the number of observed vehicles in the class to yield an average number of equivalent axle loads, EALs, per vehicle of that class.

5.10 *Violations*—Violations of all user-set parameters shall be determined by Type I, Type II, Type III, and Type IV WIM systems. A 2-character violation code, such as shown in Table 4, shall be used for each detected violation and shall be included in the displayed data. Provision shall be made for the user to define up to 15 violation codes. An additional optional feature that calls attention to any data items that are in violation of user-set limits may be specified by the user, for example, flashing, underlining, bold-facing, or audio tones.

TABLE 4 Violation Code

Violation	Code
Wheel Load	WL
Axle Load	AL
Axle—Group Load	AG
Gross-Vehicle Weight	GV
Bridge—Formula Load	BF
Over Speed	OS
Under Speed	US
Acceleration	AC
Deceleration	DE

5.11 *Acceleration*—Type III and Type IV WIM systems shall measure vehicle acceleration, which is a change in velocity. Negative acceleration is also called deceleration. The forces acting on a vehicle to produce acceleration can effect significant change in the distribution of the gross-vehicle weight among the axles and wheels of the vehicle as compared to the distribution when the vehicle is static. Therefore, any severe acceleration while the vehicle is passing over the WIM-system sensors can invalidate wheel and axle loads estimated by the system. Average acceleration of 2 ft/s^2 (0.6 m/s^2) or greater during the time that the wheelbase (see 5.8) of the vehicle is passing over the tire-force sensors should be considered as a violation. This value shall be user-adjustable, but the vendor shall program 2 ft/s^2 (0.6 m/s^2) as the default value in these WIM systems.

5.12 *User-Assignable Code*—For Type I, Type II, Type III, and Type IV WIM systems, provision shall be made to allow manual entry of a user-assignable three-digit code into any vehicular data set prior to recording.

5.13 *Tire-Force Sensor*—As the tires of a vehicle being weighed in motion might travel anywhere between the instrumented traffic lane edges, it is necessary for the magnitude of the signal from the tire-force sensor(s) in the lane to be the same (within tolerance) for a given applied tire force(s), regardless of the lateral position of the tire(s) within the lane, if consistent load and weight estimates are to be made by a WIM system.

5.13.1 Therefore, the user shall specify that every tire-force sensor installed for use with a Type I, Type III, or Type IV WIM system shall be certified by the vendor to have been tested prior to installation and found to produce signals that were linearly proportional, within 2 % of the applied load, to a simulated tire load. The simulated tire load shall be applied at three levels: 10, 50, and 90 % of rated sensor capacity. Each level of applied load shall be measured such that its magnitude is known to be within 0.25 % of its true value, for example, via a NIST-certified load cell. Loads shall be applied at the approximate longitudinal center (in the direction of traffic movement) of the sensor and at three equally spaced intervals laterally between the ends of each half-lane-width portion (nominally, 6 ft (1.8 m)) of the sensor. The maximum allowable difference (tolerance) between the highest and the lowest of the three signal values recorded at any load level shall be 2 % of the highest value.

5.13.2 The user shall specify that every sensor, usually a piezo-type axle-load sensor, nominally 12 ft (3.6 m) long to cover a full lane width, installed for use with a Type II WIM system shall be certified by the vendor to have been tested

under known impact loads applied at multiple, evenly-spaced intervals of 1 ft (0.3 m) or less along the length of the sensor prior to installation and found to meet Class I signal-uniformity tolerances (better than seven percent) (5).

6. User Requirements

6.1 *Site Conditions*—In order for any WIM system to perform properly, the user must provide and maintain an adequate operating environment for the system's sensors and instruments. Construction or selection of each WIM site, as well as continuing maintenance of the site and the sensors, are extremely important user considerations. The following site conditions, or better, shall be provided by the user if the performance criteria given in this specification are to be consistently realized. The user must recognize that the performance of the WIM system depends uniquely upon the quality of the sensors and their prevailing operating environment. System performance is degraded by less-than-ideal site conditions, even though the WIM-system sensors, instruments, and algorithms are capable of high-quality performance. The user can require quality of performance only in proportion to the quality of the site conditions provided.

6.1.1 *Horizontal Alignment*—The horizontal curvature of the roadway lane for 200 ft (60 m) in advance of and 100 ft (30 m) beyond the WIM-system sensors shall have a radius not less than 5700 ft (1.7 km) measured along the centerline of the lane for all types of WIM systems.

6.1.2 *Longitudinal Alignment (Profile)*—The longitudinal gradient of the road surface for 200 ft (60 m) in advance of and 100 ft (30 m) beyond the WIM system sensors shall not exceed 2 % for Type I, Type II, and Type III WIM-system installations, and shall not exceed 1 % for Type IV installations.

6.1.3 *Cross Slope*—The cross-slope (lateral slope) of the road surface for 200 ft (60 m) in advance of and 100 ft (30 m) beyond the WIM-system sensors shall not exceed 3 % for Type I, Type II, and Type III WIM system installations, and shall not exceed 1 % for Type IV installations.

6.1.4 *Lane Width and Markings*—The width of the paved roadway lane for 200 ft (60 m) in advance of and 100 ft (30 m) beyond the WIM-system sensors shall be between 12 and 14 ft (3.6 and 4.3 m), inclusive. For Type III, except those with sensors in the main highway lanes, and Type IV WIM systems, the edges of the lane throughout this distance shall be marked with solid white longitudinal pavement marking lines 4 to 6 in. (100 to 150 mm) wide. At least 3 ft (1 m) of additional clear space for wide loads shall be provided on each side of the WIM-system lane.

6.1.5 *Surface Smoothness*—To allow reliable WIM-system performance within the tolerances shown in Table 2, the surface of the paved roadway 200 ft (60 m) in advance of and 100 ft (30 m) beyond the WIM-system sensors shall be smooth before sensor installation and maintained in a condition such that a 6-in. (150-mm) diameter circular plate 0.125-in. (3 mm) thick cannot be passed beneath a 20-ft (6-m) long straightedge when the straightedge is positioned and maneuvered in the following manner:

6.1.5.1 Beginning at the longitudinal center of the WIM-system sensors, or sensor array, place the straightedge along each respective lane edge with the end furthest from the

sensors at the distances from the longitudinal center of the sensors as indicated below. Then pivot the straightedge about this end, and sweep the end nearest the sensors between the lane edges while checking clearance beneath the straightedge with the circular plate.

Lane Edge	Longitudinal distance from Center of Sensors, ft (m)
Right	20, 30, 44, 60, 76, 92, 108, 124, 140, 156, 172, 188, 204 (6, 9, 13, 18, 23, 28, 33, 38, 43, 48, 53, 58, 62)
Left	20, 36, 52, 68, 84, 100, 116, 132, 148, 164, 180, 196, 212 (6, 11, 16, 21, 26, 30, 35, 40, 45, 50, 55, 60, 65)

6.1.6 Pavement Structure—The user shall provide and maintain an adequate pavement structure and surface smoothness to accommodate the WIM-system sensors throughout their service life and shall install and maintain the sensors in accordance with the recommendations of the system vendor. Experience has indicated that a Portland cement concrete (also called rigid) pavement structure generally retains its surface smoothness over a longer period of time than a bituminous (also called flexible) pavement structure under heavy traffic at a WIM site. Consideration should be given to providing a 300-ft (90-m) long continuously reinforced concrete pavement (CRCP) or a jointed concrete pavement (JCP), with transverse joints spaced 20 ft (6 m) or less apart, at permanent WIM sites on freeways and principal arterial highways. (See Terminology E 867 for definitions of pavement types.) The surface of every such rigid pavement should be ground smooth after curing and before installing WIM sensors. The user should assure that the skid resistance (See Terminology E 867) of the surface after grinding is at least as good as that of the adjacent surfaces. At a site with flexible pavement, a 50-ft (15-m) long section comprising full-depth-asphalt, or black-base, design should be considered for installation at each end of the Portland cement concrete pavement structure to effect a stiffness transition between the two pavement structural types. Maintenance, replacement, or repair activity at a WIM site under traffic is hazardous and expensive; therefore, the installation should be done right the first time.

6.1.7 Instrument Environment—The user shall provide and maintain a climatic environment for the WIM-system instruments in accordance with those specified by the user and agreed upon by the system vendor.

6.1.8 Power—The user shall provide and maintain an adequate electrical power supply at each WIM site, or specify an optional battery-powered system as described in 4.1, or both.

6.1.9 Data Communication—The user shall provide and maintain an adequate data communication link between the WIM site and the remote host computer where data will be processed. This link can also serve to monitor the performance of the WIM system and adjust its settings from a remote location.

6.1.10 Temperature Range—The user shall specify the reasonable maximum and minimum ambient air temperatures in which the WIM system being procured will be operated, and the vendor shall supply evidence that the system offered is capable of performing properly within this temperature range.

6.2 Options, Exceptions, and Additional Features—Any desired optional features described in Sections 4 and 5, any

exceptions, and any additional features of the WIM system shall be specified by the user. The user shall also specify the data items to be included in the display, the number of vehicle records to be displayed simultaneously, and whether the ability to hold a selected record(s) on display without interference with continuous data taking by the system is required. The user should note that the number of data items selected will affect the number of vehicle records that can be displayed simultaneously.

6.3 Recalibration—The user shall recalibrate every WIM system following any significant maintenance or relocation. Recalibration shall be performed no less frequently than annually. Abrupt or unusual changes in data patterns can also indicate the need for recalibration. Recalibration of system Types I, II, and III shall be performed in accordance with the method presented in 7.5, and system Type IV shall be recalibrated in accordance with the method presented in 7.4.5 to ensure consistent performance.

6.4 Acceptance Test—As part of every new WIM system procurement contract, or any major modification contract on an existing system, the user shall specify the test method and the schedule for testing that will be accomplished prior to final acceptance by the user and final payment to the vendor. This test shall be conducted on-site by the user or the user's authorized representative in cooperation with the vendor, after the system has been installed or modified and calibrated (see 7.5). The specification shall state clearly the proportions of initial-calibration and acceptance-test expenses to be borne by the user and by the vendor, including the expenses for providing and operating test vehicles and for traffic control. The On-site Acceptance Test described in 7.6 may be referenced for this purpose.

6.4.1 Implications of a Type-Approval Test—The acceptance-test specification should require that the WIM system being offered by the vendor pass a rigorous Type-Approval Test, conducted under excellent site conditions (see 6.1), to demonstrate that the system is capable of performing adequately under such conditions. This test verifies the functionality of all features of the system, as well as its highest potential accuracy when the sensors are subjected to loads from a wide range of vehicle types. If the vendor provides credible evidence that the type and model of system being offered has already successfully passed the applicable Type-Approval Test described in Section 7 and the user provides site conditions that meet or exceed those given in 6.1, the system will be expected to perform at the site within the tolerances stated in Section 5. If it fails to perform within these tolerances in an on-site acceptance test where the site conditions meet or exceed those given in 6.1, the indication is that the installed system is faulty and the vendor shall be responsible for corrective action. However, if the vendor does not provide evidence of previous Type-Approval testing, the user will not be assured of the capability of the system and shall either require conduct of a Type-Approval Test (expenses to be negotiated) wherein the user shall provide appropriate site conditions (see 6.1), or reach an agreement with the vendor before the on-site acceptance test begins as to the specific, quantified tolerance values that will be acceptable if the site conditions provided by the user do not

meet or exceed those given in 6.1. In the latter case, the responsibility for inadequate WIM-system performance can lie with the vendor, the user, or both.

6.4.2 On-Site Acceptance Test—The On-Site Acceptance Test described in 7.6 may be used in lieu of a full Type-Approval Test under the circumstances outlined in 6.4.1. It is an abbreviated form of the Type-Approval Test that indicates primarily the effects of the prevailing site conditions upon the performance of a capable WIM system.

7. Test Methods for WIM System Performance

7.1 Scope—Test methods for evaluating the performance of each type of WIM systems are presented in this section. Procedures are given for conducting a Type-Approval Test (see 7.2, 7.3, 7.4) for any new or modified type or model WIM system, and an On-Site Acceptance Test (see 7.6) for newly-installed equipment at a site. Also included in this section is a Calibration Procedure for on-site calibration (see 7.5)—to remove as much bias as practicable from the weight, load, and axle-spacing estimates—to be used at the time of system installation or whenever site conditions or equipment have changed. Both tests and the calibration procedure require weighing and measuring static vehicles to determine reference values against which WIM-system-estimated values will be compared. The recommended procedure for weighing static vehicles is outlined next.

7.1.1 Apparatus for Weighing Static Vehicles—All apparatus used for weighing static vehicles shall be certified as meeting the applicable maintenance tolerance specified in *NIST Handbook 44* (1) within 30 days prior to use. When wheel-load data are required from the WIM system, the corresponding reference tire-load values for Type I, Type III, and Type IV WIM systems shall be determined with wheel-load weighers that meet the respective tolerance specification of *NIST Handbook 44*. (1) The minimum number of wheel-load weighers required is 2 and the preferred minimum number is 6. Alternatively, an axle-load scale or a multi-platform vehicle scale that has approaches and aprons adjacent to the load-receiving platform(s) that can support the tire-pavement contact surfaces of all tires on the vehicle being weighed as described in 7.1.2 may be used to weigh wheel loads on one end of an axle by positioning the wheel(s) on the other end of the axle on the adjacent apron. When this alternative technique is used, the wheel loads on both ends of the axle shall be determined, and then used only to apportion the measured axle load between the wheels on each end of the axle. When wheel-load data are not required, axle-load scales, multi-platform vehicle scales, portable axle-load weighers, or a pair of wheel-load weighers that meet the respective tolerance specification of *NIST Handbook 44*, (1) shall be used for obtaining reference tire-load values for Type II and Type III WIM systems. Either an axle-load scale or a multi-platform vehicle scale, along with wheel-load weighers if required, shall be used for measuring reference tire-load values for Type III and Type IV WIM systems.

7.1.2 Use of Apparatus for Weighing Static Vehicles—The tire-pavement contact surfaces of all tires on the vehicle being weighed shall be within 0.25 in. (6 mm) of a plane passing through the load-receiving surface(s) of the multi-platform vehicle scale, wheel-load weighers, portable axle-load weigh-

ers, or axle-load scales whenever any tire-load measurement is made. The maximum slope of this plane from horizontal shall be 2 %. Suitable blocking or mats may be utilized, or the weighing device(s) may be recessed into the pavement surface to provide the required vertical orientation of the tire-pavement contact surfaces. When wheel-load information is required, wheel and axle load shall be measured simultaneously using a pair of wheel-load weighers. When wheel-load information is not required, axle-load shall be determined by positioning each axle to be weighed either simultaneously or successively on an axle-load scale(s), a multi-platform vehicle scale, a portable axle-load weigher(s), or a pair(s) of wheel-load weighers. Axle-group load shall be determined either by positioning all axles in the group simultaneously on the required number of weighing devices (preferred) or by successively positioning each axle in the group on a pair of wheel-load weighers or on an axle-load weighing device. The number of movements of the vehicle to accomplish the successive tire-load measurements shall be minimized. A tire-load measurement shall be made only when the brakes of the vehicle being weighed are fully released and all tires are properly positioned on the load-receiving surface(s) of the weighing device(s). Suitable means (for example, chocks) shall be used to keep the tires properly positioned while the brakes are released. Gross-vehicle weight shall be the sum of all wheel loads or axle loads for the vehicle. No tire-load measurement shall be taken until oscillations induced by inertial forces (for example, via a load of undulant liquid) of the vehicle have subsided to a point that indicated tire load is changing less than three scale divisions in 3 s. If more than 6 s are required to reach this stable condition when making any tire-load measurement after the brakes on the vehicle being weighed are fully released, the vehicle shall be eliminated from the Test Unit for Type-Approval Test Loading. (see 7.2.4, 7.3.4, and 7.4.4.)

7.1.3 Procedure for Weighing and Measuring Test Vehicles to Obtain Reference Values—Two test vehicles (see 7.5.3) are used for the Calibration Procedure, the Type-Approval Test, and the On-Site Acceptance Test. The following procedure shall be applied for obtaining reference load, weight, and axle-spacing values for each of the static test vehicles.

7.1.3.1 Measure the center-to-center spacing between successive axles on each test vehicle and record these data to the nearest 0.1 ft (0.03 m) as axle-spacing reference values.

7.1.3.2 Weigh each test vehicle a minimum of three times, with brakes released, as described in 7.1.1 and 7.1.2 to measure tire loads for the wheel(s) on each end of every axle on the static vehicle. Move the vehicle completely away from the scale or weigher before beginning a new set of tire-load measurements, and always approach the weighing devices from the same direction for weighing. Sum the applicable tire loads to determine wheel, axle, and tandem-axle loads as well as gross-vehicle weight each time the vehicle is weighed.

7.1.3.3 Calculate the arithmetic mean for all wheel load, axle-load, tandem-axle-load, and gross-vehicle-weight values that resulted from weighing each test vehicle three or more times; also calculate the difference, in percent, from this mean of each individual value used in calculating the respective mean.

7.1.3.4 Compare these percent differences from the mean to the following specified limits for each applicable load or weight value for each test vehicle: gross-vehicle weight = $\pm 2\%$, tandem-axle load = $\pm 3\%$, axle load = $\pm 4\%$, and wheel load = $\pm 5\%$. These limits define a practicable range into which an individual observation must fall in order to demonstrate that the weighing process for the static vehicle is producing results that are suitable for use as reference-value loads and weights against which WIM-system estimates will be evaluated.

7.1.3.5 If any of the measured or calculated load or weight values exceeded the specified range, correct deficiencies in the reference-value weighing process and weigh each test vehicle a minimum of three more times.

7.1.3.6 Repeat 7.1.3.5 until the weighing process yields reference-value loads and weights that are within the specified range.

7.1.3.7 For reference-value loads and weights against which to compare WIM-system estimates, use the calculated arithmetic mean value for the respective wheel load, axle-load, tandem-axle-load, and gross-vehicle-weight values that resulted from successfully weighing each test vehicle three or more times.

7.2 Type-Approval Test for Type I and Type II WIM Systems:

7.2.1 *Scope*—The Type-Approval Test described here is for evaluating the performance capabilities of a new type or model WIM system under excellent site conditions and under traffic loading that is representative of that which will be of interest where Type I and Type II WIM systems will usually be applied. Performance requirements for each type of WIM system are given in Section 5 of this specification, and associated user requirements are given in Section 6. The WIM system being evaluated in the Type-Approval Test shall be subjected to a loading test unit comprising two test vehicles (see 7.5.3) plus approximately 51 additional vehicles selected from the traffic stream at the Type-Approval Test site. Other types of vehicles may be added to the loading test unit by the user who is conducting the test at any Type-Approval Test site where large numbers of vehicles in classes not already included are operating. Likewise, the user conducting the test may eliminate vehicles of a particular class(s) from the loading test unit if none appears at the site within a practicable duration of the test. For each vehicle eliminated, one of another class prevalent at the site shall be added to maintain a total of 51 vehicles in the loading test unit. Vehicles determined to be carrying a shifting or undulating load at the time of reference-value weighing (see 7.1.2) may also be eliminated. Another vehicle of the same class shall be substituted for the one eliminated. The two test vehicles, that will make multiple passes over the WIM-system sensors at the minimum and at the maximum speed specified by the user between 10 and 80 mph (16 and 130 km/h), and at intermediate speeds, provide a basis for evaluating the performance of the WIM system over a range of speeds. The additional vehicles included in the loading test unit serve the function of subjecting the WIM system to loading by a representative variety of vehicle classes. All vehicles comprising the loading test unit shall be weighed statically on certified weighing devices as described in 7.1.1, 7.1.2, and 7.1.3 at a

suitable site within reasonable proximity to the Type-Approval Test site.

7.2.2 *Significance and Use*—Interpretation of the results from the Type-Approval Test will allow the user to determine whether the tested Type I or Type II WIM system is capable of meeting or exceeding the performance requirements stated in Section 5. This can also indicate the potential upper limit of performance that can be achieved by the particular type and model of system, as the road surface conditions that potentially affect the location and magnitude of dynamic tire forces significantly, shall be the best available for conducting the Type-Approval Test and shall, as a minimum, satisfy the user requirements given in Section 6.

7.2.3 *Site for Type-Approval Test*—Both the user (or a recognized representative of user's interests) and the vendor shall approve the Type-Approval Test site as well as the WIM-system installation prior to conducting the test. The actual road-surface and WIM-system sensor conditions that prevail in each lane during type-approval testing shall be documented in terms that verify compliance with the user requirements given in 6.1.

7.2.4 *Test Unit for Type-Approval Test Loading*—The test unit for loading the WIM system being evaluated in the Type-Approval Test shall comprise two test vehicles (see 7.5.3) that will make multiple runs over the WIM-system sensors at prescribed speeds along with other vehicles selected in random order from the traffic stream at the Type-Approval Test site. The number of vehicles in each Vehicle Class (see 5.2) to be selected in random order from the traffic stream for inclusion in the test unit is shown in Table 5. See 7.2.1 concerning modification of the loading test unit.

7.2.5 *Calibration*—Within 48 h prior to beginning the Type-Approval Test, the WIM system shall be calibrated in accordance with the calibration procedure presented in 7.5.

7.2.6 *Procedure*—The user shall be in responsible charge and shall include the following steps in conducting the Type-Approval Test.

7.2.6.1 As a joint effort between the user (or a recognized representative of user's interests) and the vendor, select the best available WIM-system site that, as a minimum, meets the applicable requirements stated in 6.1.

7.2.6.2 Ensure that a suitable site for weighing vehicles statically is available within a reasonable distance of the WIM site, that traffic can be controlled safely at this location, and that test vehicles can turn around safely and conveniently for

TABLE 5 Composition of Test Unit for Type-Approval Test Loading of WIM Systems

Vehicle Class	Number of Selected Vehicles (Total = 51)
05	5
06	5
08 (2S1) ^A	4
08 (2S2)	4
08 (3S1)	4
09 (3S2)	20
11 (2S1-2)	3
12 (3S1-2) ^B	3
13	3

^A Two-axle tractor, single-axle semi trailer.

^B Three-axle tractor, single-axle semi trailer, two-axle full trailer.

multiple passes. Obtain approval from the public authority having jurisdiction over the site for the traffic control procedures that will be used during testing. Provide facilities at this site for weighing all vehicles in the loading test unit (see 7.1.1).

7.2.6.3 Install the WIM system in accordance with the vendor's recommendations and execute the calibration procedure that is presented in 7.5.

7.2.6.4 After agreement by both the user and the vendor, install the settings defined in 7.5.5.5 on the WIM-system.

7.2.6.5 Using traffic control procedures approved by the appropriate public authority and other reasonable safety precautions, have each test vehicle make five or more runs over the sensors in each lane at an attempted speed approximately 5 mph (8 km/h) less than the maximum speed, and then five or more additional runs at an attempted speed approximately 5 mph (8 km/h) greater than the minimum speed, used during calibration (see 7.5.5.3). At each speed, one or more runs shall be made with the test vehicle tires near the left-hand lane edge, and one or more runs with the test vehicle tires near the right-hand lane edge. The other runs shall be made with the test vehicle approximately centered in the lane. Weigh each test vehicle statically after or before every run over the WIM sensors (see 7.1.2). Record all data, and correlate the WIM-system vehicle record number for every run of each test vehicle with the corresponding static weighing record.

7.2.6.6 For reference speed values, measure the speed of the test vehicle each time it passes over the WIM-system sensors with a calibrated radar speed meter or by some other means (such as wheelbase/time) acceptable to both the user (or a recognized representative of user's interests) and the vendor, and record the observed speed. The radar speed meter, if used, shall be calibrated by the method recommended by its vendor within 30 days prior to use.

7.2.6.7 Make the calculations shown in 7.2.7 for the 20 or more runs (five or more runs at two speeds by two vehicles) of the test vehicles and compare the functions and performance of the WIM system with all specification requirements, including speed and axle spacing. See Section 4 for functions and Section 5 for performance tolerances.

7.2.6.8 If any WIM-system function or more than 5 % of the load, weight, or axle-spacing values resulting from all test-vehicle runs fails to satisfy the specification, the user who is in responsible charge of conducting the Type-Approval Test shall consider the fact that at least 95 % of all WIM-system-estimated values, including those resulting from runs already made by the two test vehicles plus the runs that will be made by the 51 additional vehicles to be selected from the traffic stream must meet the specified tolerances for type approval of the system, and then decide whether to continue the test.

7.2.6.9 If continuation is approved, select vehicles from the traffic stream to complete the makeup of the test unit for Type-Approval Test loading as specified in 7.2.4.

7.2.6.10 Allow each of the selected vehicles to pass over the WIM-system sensors at normal speed and require each vehicle to stop for weighing (see 7.1.1 and 7.1.2) and for measurement of axle spacing (see 7.1.3.1).

7.2.6.11 Make the calculations shown in 7.2.7 and compare the performance of the WIM system with the specification

requirements stated in Section 5 for the two test vehicles and the remainder of the vehicles in the Type-Approval Test loading unit (see 7.2.4).

7.2.6.12 Interpret and report the results as described in 7.2.8.

7.2.7 *Calculation*—Calculation is needed for defining the reference-value loads and weights of the static vehicle with which to compare WIM-system-estimated values, and evaluating conformity of data items produced by the WIM-system to specification requirements.

7.2.7.1 *Procedure for Calculating Reference-Value Loads and Weights*—Only certified weighing devices (see 7.1.1) shall be utilized for determining reference-value tire loads. Reference-value loads and weights are calculated by summing tire loads. For WIM systems that produce estimates of wheel loads, calculate reference-value axle load by summing two wheel loads, axle-group load by summing the wheel loads for all wheels in each axle group, and gross-vehicle weight by summing the wheel loads for all wheels on the vehicle. For WIM systems that do not produce estimates of wheel loads, sum the appropriate axle loads to calculate axle-group loads and gross-vehicle weight, if wheel-load weighers are not used. If wheel-load weighers are used, use the procedure stated above for summing tire loads.

7.2.7.2 *Procedure for Calculating Percent of Non-Conforming Data Items*—For each data item that is produced by the WIM system and shown in Table 2, calculate the percent difference in the value and the corresponding reference value by the following relationship:

$$d = 100[(C - R)/R] \quad (1)$$

where:

d = difference in the value of the data item produced by the WIM system and the corresponding reference value expressed as a percent of the reference value, %,

C = value of the data item produced by the WIM system, and

R = corresponding reference value for the data item.

7.2.7.3 Determine the number of calculated differences that exceeded the tolerance shown in Table 2 for each data item and express this number as a percent of the total number of observed values of this item by the following relationship:

$$P_{dc} = 100[n/N] \quad (2)$$

where:

P_{dc} = percent of calculated differences that exceeded the specified tolerance value,

n = number of calculated differences that exceeded the specified tolerance value, and

N = total number of observed values of the data item.

7.2.8 *Interpretation of Test Results and Report*—If any specified WIM-system function failed, or if more than 5 % of the calculated differences for any applicable data item (specified in Section 4) resulting from all passes of the two test vehicles (each vehicle made five or more passes at two difference speeds) and from the single pass of each selected vehicle over the sensors at normal speed exceed the specified tolerance (specified in Section 5) for that item, declare the WIM system dysfunctional or inaccurate and report that it

failed the Type-Approval Test. Regardless of whether the system fails or passes the Type-Approval Test, tabulate all data used in making the determination, including the surface conditions, and send the results to ASTM Committee E17 on Vehicle-Pavement Systems within 90 days after completion of on-site data collection so that statements about bias and precision of the test can be formulated as experience is accumulated.

7.2.9 Precision and Bias—A statement about precision and bias of a test method should allow potential users of the test to assess in general terms its usefulness for a particular purpose. It is intended to provide guidance as to the amount of variation that can be expected in test results when the test is conducted in one or more comparable laboratories or situations. This is a test method that produces pass-or-fail results. The precision and bias of the procedure and calculations in this acceptance test for Type I and Type II WIM systems are being determined.

7.3 Type-Approval Test for Type III WIM Systems:

7.3.1 Scope—A procedure is given for conducting a Type-Approval Test of a Type III WIM system. This type system is designed for installation at weight-enforcement stations with sensors off the main highway lanes, or in one or more main highway lanes, to identify vehicles operating within a user-specified range of speeds between 10 and 80 mph (16 and 130 km/h), inclusive, that are suspected of weight-limit or load-limit violation. The system must also control official traffic-control devices that direct suspect vehicles to a scale for confirmation weighing and measurement and direct non-suspect vehicles past the scales without stopping. The Type-Approval Test shall be conducted under excellent site conditions and under traffic that includes vehicles that are representative of the vehicle classes of interest where Type III WIM systems will usually be installed. Performance requirements for this type system are presented in Section 5, and user requirements are given in Section 6. Tolerances for Type III WIM systems are somewhat smaller than for Types I and II, as the required reference-value weighing devices are continually available for on-site calibration at any chosen time. Test loading for the Type-Approval Test is designed to allow evaluation of the variability in measured or calculated loads and weights of static vehicles as well as the accuracy of WIM-system estimates of the various data items produced by the system. Capability of the system to detect excessive acceleration of a vehicle while it is over the off-main-lane WIM-system sensors is also evaluated. All vehicles used for test loading the Type III WIM system shall be weighed statically as described in 7.1.1 and 7.1.2 using the certified scales installed at the weight-enforcement site where the Type-Approval Test is conducted. When the sensors of the Type III WIM system are installed in the main highway lanes, the Type-Approval Test procedure shall be basically the same as described herein except that the deceleration testing described in 7.3.6.1 will not be conducted. The Type III system shall accommodate the same speed criteria as a Type I system, and the tolerances for 95 % probability of conformity shown in Table 2 for load and weight values for a Type III system shall be satisfied.

7.3.2 Significance and Use

—Interpretation of the results

from the Type-Approval Test will allow the user to determine whether the tested Type III WIM system is capable of meeting or exceeding the performance requirements stated in Section 5. This can also indicate the potential upper limit of performance that can be achieved by the particular type of system as the road surface conditions that potentially affect the location and magnitude of dynamic tire forces significantly shall be the best available for conducting the Type-Approval Test and shall, as a minimum, satisfy the user requirements shown in Section 6.

7.3.3 Site for Type-Approval Test

—See 7.2.3.

7.3.4 Test Unit for Type-Approval Test Loading—The test unit for loading the WIM system being evaluated in the Type-Approval Test shall be the same as specified in 7.2.4, except that each vehicle selected from the traffic stream for inclusion in the loading test unit shall have one or more of the following loads or weights that is at least 80 % of the applicable legal limit: gross-vehicle weight, axle-group load, axle load, or wheel load.

7.3.5 Calibration

—See 7.2.5.

7.3.6 Procedure—The procedure for conducting the Type-Approval Test for Type III WIM systems shall be the same as described in 7.2.6 with the following exceptions:

7.3.6.1 After 7.2.6.8, if continuation is approved, verify the ability of the WIM system with sensors installed off the main highway lanes to detect excessive acceleration by having the driver of each loaded test vehicle approach the WIM-system sensors at a speed between 30 and 40 mph (50 and 60 km/h), inclusive, and apply heavy braking for approximately 1 s while the vehicle is passing over the sensor array. Excessive negative acceleration (deceleration) should be indicated by the Violation Code DE (see Table 4). Compare the WIM-system estimates of weights for these runs with those for steady-speed runs and include these comparisons in the data reported to ASTM Committee E17 on Vehicle-Pavement Systems. Proceed with 7.2.6.9.

7.3.7 Calculation

—See 7.2.7.

7.3.8 Interpretation of Test Results and Report

—See 7.2.8.

7.3.9 Precision and Bias—The precision and bias of the procedure and calculations in this Type-Approval Test for the Type III WIM system are being determined.

7.4 Type-Approval Test for Type IV WIM Systems:

7.4.1 Scope—The Type IV WIM system is designed to detect weight-limit or load-limit violations by highway vehicles for enforcement purposes. Even though this type WIM system has not yet been approved for use in the United States, a procedure for type-approval testing to determine conformity with the performance requirements specified in Section 5 is presented. The procedure includes data collection needed for evaluating the variability in reference-value tire loads measured by certified wheel-load weighers, axle-load scales, a multi-platform vehicle scale, or a combination thereof, as well as the performance of the WIM-system in either measuring the tire loads of a vehicle stopped on the WIM-system sensors or estimating the tire loads and dimensions of a static vehicle from measurements made with the vehicle moving at a steady speed of 10 mph (16 km/h) or less. Reference-value tire loads shall be measured by a multi-platform vehicle scale or an axle-load scale (see 7.1.1) when Option 2, exempting the Type

IV WIM system from producing wheel-load information, (see 4.1.4) has been specified for the Type IV WIM system under test. When this option has not been specified, wheel-load values are required, and reference-value tire loads shall be measured by placing wheel-load weighers directly on the load-receiving surface of the multi-platform vehicle scale or the axle-load scale and raising all tire-pavement contact surfaces approximately into the same plane as described in 7.1.2. The sum of the tire-load values from the wheel-load weighers should compare, within applicable tolerances, with the corresponding value from the scale upon which they are placed; then, the wheel-load-weigher indications should be used only to apportion the axle load indicated by the scale between the wheels on the axle. Alternatively, an axle-load scale or a multi-platform vehicle scale that has approaches and aprons adjacent to the load-receiving platform(s) that can support the tire-pavement contact surfaces of all tires on the vehicle being weighed as described in 7.1.2 may be used to weigh wheel loads on one end of an axle by positioning the wheel(s) on the other end of the axle on the adjacent apron. When this alternative technique is used, the wheel loads on both ends of the axle shall be determined, and then used only to apportion the measured axle load between the wheels on each end of the axle.

7.4.2 Significance and Use—Interpretation of the results from the Type-Approval Test will allow the user to determine whether the tested Type IV WIM system is capable of meeting or exceeding the performance requirements stated in Section 5. This can also indicate the potential upper limit of performance that can be achieved by the particular type of system as the test conditions at the weight-enforcement site shall be the best available for conducting the Type-Approval Test and shall, as a minimum, satisfy the user requirements shown in Section 6.

7.4.3 Site for Type-Approval Test—Either an axle-load scale or a multi-platform vehicle scale is required at the site. Other site requirements are the same as 7.2.3. Neither the longitudinal profile nor the cross slope shall exceed 1 %.

7.4.4 Test Unit for Type-Approval Test Loading—See 7.3.4.

7.4.5 Calibration—Within seven days prior to beginning the Type-Approval Test, every Type IV system that uses tire-force sensors (see 5.13) that support the entire tire-contact area(s) of all tires on a wheel assembly simultaneously shall, when subjected to field standard test weights (see 5.13.1), be adjusted to meet the acceptance tolerance for wheel-load weighers or for portable axle-load weighers as stated in *NIST Handbook 44* (1), depending upon whether wheel-load data or only axle-load data (4.1.4, Option 2) are of interest. Type IV systems that use tire-force sensors that support only part of the tire-contact area(s) at one time during dynamic tire-force measurements shall be calibrated within this same time period as described in 7.5, except the speeds (see 7.5.5.3) shall be 2 and 10 mph (3 and 16 km/h) (see 4.1.4). All weighing apparatus used in the Type-Approval Test for determining reference-value tire loads shall be certified as meeting the applicable maintenance tolerance specified in *NIST Handbook 44* (1) within 30 days prior to beginning the Type-Approval Test.

7.4.6 Procedure—The procedure for conducting the Type-

Approval Test for Type IV WIM systems shall be the same as described in 7.2.6 with the following exceptions:

7.4.6.1 In 7.2.6.2, also ensure that an axle-load scale or a multi-platform vehicle scale is available at or near the site,

7.4.6.2 In 7.5.5.3, 7.2.6.5 and 7.2.6.10, the respective minimum, intermediate, and maximum speeds of the test vehicles shall be 2, 6, 8, and 10 mph (3, 10, 13, and 16 km/h),

7.4.6.3 In 7.2.6.9, calculate the difference in each load or weight from the arithmetic mean and compare the difference to one-half the applicable tolerance for a Type IV WIM system shown in Table 2.

7.4.6.4 After 7.2.6.8, if continuation is approved, verify the ability of the WIM system to detect excessive acceleration by having the driver of each loaded test vehicle approach the WIM-system sensors at a speed between 8 and 10 mph (12 and 16 km/h) and apply heavy braking for approximately 1 s while the vehicle is passing over the sensor array. Excessive negative acceleration (deceleration) should be indicated by the Violation Code DE (see Table 4). Compare the WIM-system estimates of loads and weights for these runs with those for steady-speed runs and include these comparisons in the data reported to ASTM Committee E17 on Vehicle-Pavement Systems. Proceed with 7.2.6.9.

7.4.6.5 In 7.2.7.2, calculate the differences in WIM-estimated load and weight values from their respective reference values and express the differences in pounds (kilograms), rather than percent.

7.4.7 Calculation—See 7.2.7 except as described in 7.4.6.5.

7.4.8 Interpretation of Test Results and Report—See 7.2.8.

7.4.9 Precision and Bias—The precision and bias of the procedure and calculations in this Type-Approval Test for the Type IV WIM system are being determined.

7.5 Calibration Procedure for Type I, Type II, and Type III WIM Systems:

7.5.1 Scope—A procedure is given for on-site calibration of Type I, Type II, and Type III WIM systems. This procedure shall be conducted by the user with cooperation of the vendor, or by their authorized representatives as a fundamental part of every Type-Approval Test and is recommended for inclusion in every On-site Acceptance Test (see 7.6). It requires that two loaded, pre-weighed and measured (see 7.1.3) test vehicles each make multiple runs over the WIM-system sensors in each lane at specified speeds.

7.5.2 Significance and Use of Calibration—The tire-force sensors of a WIM system are typically designed to produce a signal, with respect to time, that is linearly proportional to the magnitude of the component of dynamic tire force applied perpendicularly to the road surface by the tires of a moving vehicle. The function of calibration is to define factors, that will be subsequently applied within WIM-system calculations to correlate the observed vehicle speed and tire-force signals with the corresponding tire-load and axle-spacing values for the static vehicle. The dynamic tire force results from a complex interaction among the vehicle components, the WIM-system sensors, the road surface surrounding the sensors, and other factors. Road-surface profiles and sensor installation are different at every WIM site, and every vehicle has unique tire, suspension, mass, and speed characteristics. Therefore, it is

necessary to recognize the effects of these site-specific, speed-specific, and vehicle-specific influences on WIM-system performance and attempt to compensate for their adverse effects as much as is practicable via on-site calibration. The calibration procedure shall be applied immediately after the initial installation of a Type I or Type II, or Type III WIM system at every site. It shall be applied again when a system is reinstalled or whenever site conditions or WIM-system components (including software and settings) have changed significantly. Recalibration shall be performed no less frequently than annually.

7.5.3 Test Unit for Calibration Loading—The test unit for calibration loading shall comprise two loaded, pre-weighed, and measured test vehicles that will make multiple runs over the WIM-system sensors in each lane at prescribed speeds. One of the loaded test vehicles shall be Class 05 and the other Class 09 (see Table 3). These test vehicles shall have a suspension type (leaf spring, air, other) that is deemed by the user to be representative of most vehicles of their type operating at the site. They shall be loaded to at least 90 % of their respective registered gross-vehicle weight with a non-shifting, approximately-symmetric (side-to-side) load and shall be in excellent mechanical condition. Special care shall be exercised to ensure that the tires on the test vehicles are in excellent condition (preferably dynamically balanced) and inflated to recommended pressures. Reference-value weighing and measurement of the two test vehicles shall be in accordance with 7.1.3.

7.5.4 Site Conditions—Before initial calibration begins, the existing site conditions (see 6.1) in each lane where WIM-system sensors are installed shall be described quantitatively and made a matter of permanent record for future reference (see 6.1.5 for surface smoothness measurement). Estimates of the location and magnitude of each observed pavement surface deviation greater than the 0.125 in. (3 mm) measured beneath the straightedge with the circular plate should be documented. Record the time and the approximate ambient air temperature at the beginning, during, and at the end of the calibration process. After initial calibration, alternative means of measuring the surface smoothness of the paved roadway 200 ft (60 m) in advance of and 100 ft (30 m) beyond the WIM-system sensors may be used to avoid closing the traffic lane. Data from suitable inertial profiling instruments analyzed via computer simulation of the 20-ft (6-m) straightedge and circular plate is suggested as a possible alternative measurement technique.

7.5.5 Procedure—The following steps are involved in the on-site calibration process for each instrumented lane:

7.5.5.1 Adjust all WIM-system settings to vendor's recommendations or to a best estimate of the proper setting based upon previous experience.

7.5.5.2 With a calibrated radar speed meter or by some other means (such as wheelbase/time) that is acceptable to both the user (or a recognized representative of user's interests) and the vendor, measure the speed of each test vehicle every time it passes over the WIM-system sensors. The radar speed meter, if used, shall be calibrated by the method recommended by its vendor within 30 days prior to use.

7.5.5.3 Using traffic control procedures approved by the appropriate public authority and other reasonable safety pre-

cautions, have each test vehicle (see 7.5.3) make a series of three or more runs over the WIM-system sensors at the minimum and at the maximum speed specified by the user who is conducting the test between 10 and 80 mph (16 and 130 km/h) for Type I, Type II, and Type III systems. The maximum specified speed shall be less than the legal speed limit at the site. These two speeds should differ by at least 20 mph (30 km/h) and should be above and below the average speed of vehicles operating at the site. Then, have each test truck pass over the sensors three or more times at an intermediate speed that is representative of the prevailing speed of truck traffic at the site. At each speed, one or more runs shall be made with the test vehicle tires near the left-hand lane edge, and one or more runs with the test vehicle tires near the right-hand lane edge. The other runs shall be made with the test vehicle approximately centered in the lane. Record all data, and note the vehicle record number for every run of each test vehicle.

7.5.5.4 Calculate the difference in the WIM-system estimate and the respective reference value for the two test vehicles for each speed, wheel-load, axle-load, tandem-axle load, gross-vehicle-weight, and axle-spacing value, express the difference in percent (see 7.2.7), and find a mean value for the differences for each set of values.

7.5.5.5 Make the necessary changes, according to the vendor's recommendations, to the WIM-system settings that will adjust the mean value of the respective differences for each value to equal approximately zero. For WIM systems that estimate wheel load (Type I and perhaps other types), the adjustment will be to wheel-load estimates on each side of the vehicles, separately. For systems that estimate axle loads only, the adjustment will be for axle loads. Some WIM systems allow calibration factors to be defined and applied for selected wheels, axles, or axle groups in relation to their respective location on the vehicle or combination; this is a feature that can potentially improve WIM-system tire-load estimates. It is also important for the WIM system to include a feature that invokes the proper set of calibration factors for use in estimating load, weight, and axle spacing values when the observed vehicle is running at a particular, measured speed. These factors can be derived from the measurements made when the two test vehicles each made three or more runs at three different speeds. Every vehicle interacts with the road surface differently at different speeds, but about the same at the same speed. Adjustment to the speed setting will probably affect axle-spacing estimates.

7.6 On-Site Acceptance Test for Type I, Type II, and Type III WIM Systems:

7.6.1 Scope—This test method provides the WIM-system user with a practicable means for determining whether or not a new or modified Type I, Type II, or Type III system that has been installed at a particular site meets or exceeds specified functional and performance requirements (see Sections 4 and 5) and defines for the user and the vendor the test method that will be applied for evaluating the installed WIM system. It also requires the user to quantify and document the site conditions that exist at the site (see 6.1 and 7.5.4) when the test is conducted. It uses two test vehicles for the test loading unit and is an abbreviated form of the more-rigorous Type-Approval

Test (see 7.2 and 7.3) for these WIM-system types that may be used in lieu of a full Type-Approval Test under the circumstances outlined in 6.4.1.

7.6.2 Significance and Use—In procuring a new WIM system or in contracting for a major modification to an existing system for use at a particular site, the user shall specify (see 6.4) an acceptance test method and the schedule of testing that will be accomplished prior to final acceptance of the product or service by the user and final payment to the vendor. The On-site Acceptance Test described here may be referenced for this purpose in the specification.

7.6.3 Procedure—The test shall be conducted on-site by the user or the user's authorized representative, in cooperation with the vendor, immediately after a Type I, Type II, or Type III WIM System has been installed or modified. The following steps are required for each instrumented lane.

7.6.3.1 Execute the Calibration Procedure as presented in 7.5 and install the settings defined in 7.5.5.5 on the WIM-system. If agreed upon in advance by both the user and the vendor, another calibration procedure may be used in lieu of the one presented in 7.5 for conducting the On-site Acceptance Test.

7.6.3.2 With the settings agreed upon by both the user and the vendor installed on the WIM system, have each of the two test vehicles (see 7.5.3) make five or more runs over the sensors in each lane at an attempted speed approximately 5 mph (8 km/h) less than the maximum speed, and then five or more additional runs at an attempted speed approximately 5 mph (8 km/h) greater than the minimum speed, used during calibration (see 7.5.5.3). At each speed, one or more runs shall be made with the test vehicle tires near the left-hand lane edge, and one or more runs with the test vehicle tires near the right-hand lane edge. The other runs shall be made with the test vehicle approximately centered in the lane. With a calibrated radar speed meter, or by some other means (such as wheelbase/time) that is acceptable to both the user and the vendor, measure the speed of each test vehicle every time it passes over

the WIM-system sensors. Record all data, and note the vehicle record number for every run of each test vehicle. The radar speed meter, if used, shall be calibrated by the method recommended by its vendor within 30 days prior to use.

7.6.4 Calculation—Make the calculations shown in 7.2.7 for the 20 or more runs (five or more runs at two speeds by two vehicles) of the test vehicles and compare the functions and performance of the WIM system with all specification requirements, including speed and axle spacing. See Section 4 for functions and 4.1.3, Section 5, and 6.4.1 for performance tolerances.

7.6.5 Interpretation of Test Results and Report—All specified data-collection features, data-processing features, and options of the system type described in Section 4 shall be demonstrated to function properly before the system is accepted. If any of these fails to function properly, or if more than 5 % of the calculated differences for any applicable data item resulting from all passes of the two test vehicles exceeded the tolerance specified in 4.1.3, Section 5, or 6.4.1 for that item and WIM-system type, declare that the WIM system was dysfunctional or inaccurate and record the fact that it failed the On-Site Acceptance Test. Regardless of whether the system fails or passes the test, tabulate all data used in making the determination, including the surface conditions, and send the results to ASTM Committee E17 on Vehicle-Pavement Systems within 90 days after completion of on-site data collection so that statements about bias and precision of the test can be formulated as experience is accumulated.

7.6.6 Precision and Bias—This is a new test method that produces pass-or-fail results. The precision and bias of the procedure and calculations in this On-site Acceptance Test for Type I, Type II, and Type III WIM systems are being determined.

8. Keywords

8.1 axle load; pavement and bridge; traffic; vehicle; weighing vehicles; weigh-in-motion; weight enforcement; WIM

ANNEX

(Mandatory Information)

A1. COMPUTATION OF EQUIVALENT SINGLE-AXLE LOADS (ESALs) BY WIM SYSTEMS

A1.1 Load Equivalence Factors and ESALs

A1.1.1 A numerical factor that defines the number of applications of a chosen standard axle load and type that is expected to cause damage to a specified pavement structure equivalent to the damage that will be caused by one pass of an axle load and type under consideration is called a Load Equivalence Factor (LEF). The vehicle records produced by Type I and Type II WIM systems (see 4.1.1 and 4.1.2) include data for defining axle load (see 3.2.4) and type (front, single, tandem, triple) for each individual axle or axle set (see 3.2.7, 3.2.8, 3.2.11).

A1.1.2 Equivalent Single Axle Loads (ESALs) are the cumulative number of applications of the chosen standard

single-axle load that will have an equivalent effect on pavement serviceability as all applications of various axle loads and types by vehicles in a mixed-traffic stream. ESALs are determined by summing the calculated LEF for each individual axle or axle set according to axle load and type on all vehicles in the measured or assumed mixed-traffic stream for the defined pavement structure.

A1.1.3 AASHTO Load Equivalence Factors—The load equivalence factors, LEFs, that were derived from statistical analysis of data taken during the AASHTO (now AASHTO) Road Test (3, 4) are frequently used for pavement design and analysis. For use in the *AASHTO Interim Guides for Design of Pavement Structures, 1972 and 1981*, and in subsequent

AASHTO Guides for Design of Pavement Structures, 1986 and 1993, (see 2.2), an 18 000-lb single axle was chosen as the standard axle load and type for calculating LEFs for flexible and rigid pavements. In addition to axle load and axle type, each LEF depends on the structural capacity (structural number, $\overline{SN}$) of a flexible pavement or on the thickness, D , of a rigid pavement, plus the terminal condition that is chosen to define failure of the pavement structure (terminal serviceability, p_t). The AASHTO equations for calculating LEFs for both flexible and rigid pavements are presented in the following sections.

A1.2 AASHTO Axle Load Equivalence Factors and ESALs for Flexible Pavements

A1.2.1 AASHTO Design Equations—The design equations for flexible pavements presented in the *AASHTO Interim Guide for Design of Pavement Structures, 1972, Appendix C* (see 2.2), are:

$$\log W_t = 5.93 + 9.36 \log (\overline{SN} + 1) - 4.79 \log (L_1 + L_2) + 4.33 \log L_2 + \frac{G_t}{\beta} \quad (\text{A1.1})$$

$$\beta = 0.40 + \frac{0.081 (L_1 + L_2)^{3.23}}{(\overline{SN} + 1)^{5.19} L_2^{3.23}} \quad (\text{A1.2})$$

$$G_t = \log \left[\frac{4.2 - p_t}{4.2 - 1.5} \right] \quad (\text{A1.3})$$

where:

W_t = number of axle load applications at the end of time t for axles with dual tires,

$\overline{SN}$ = structural number, an index number derived from analysis of traffic, roadbed soil conditions, drainage, and regional factor that may be converted to a thickness of flexible pavement layers through the use of suitable layer coefficients that are related to the layer thickness and modulus of the material being used in each layer of the pavement structure,

L_1 = load on one single axle, or on one tandem-axle set, lb/1000,

L_2 = axle-type code: 1 for a single axle, 2 for a tandem-axle set,

β = a function of design and load variables that influences the shape of the P versus W serviceability curve,

G_t = a function (the logarithm) of the ratio of loss in serviceability at time t to the potential loss taken to a point where $p_t = 1.5$, and

p_t = serviceability at the end of time t ; terminal serviceability. (Serviceability is the ability of a pavement at the time of observation to serve high-speed, high-volume automobile and truck traffic.).

A1.2.2 Calculation of AASHTO LEFs—The design equation (Eq A1.1) for flexible pavements can be arranged into a ratio format and solved to calculate a load equivalence factor. The number of applications of an 18 000-lb single-axle load $W_{t_{18,1}}$ that is expected to cause an equivalent change in serviceability to a flexible pavement with the same structural number $\overline{SN}$ and terminal serviceability p_t as one application $W_{t_{L,n}} = 1$ of an axle load under consideration L_i and axle type

n is called the Load Equivalence Factor, $LEF_{L,n}$. This load equivalence factor can be calculated by solving the following equations. (6)

$$LEF_{L,n} = \frac{W_{t_{18,1}}}{W_{t_{L,n}}} = \left[\frac{(L_i + n)^{4.79}}{(18 + 1)^{4.79}} \right] \left[\frac{10^{G_t/\beta_{18,1}}}{(10^{G_t/\beta_{L,n}}) (n^{4.33})} \right] \quad (\text{A1.4})$$

$$\beta_{L,n} = 0.40 + \frac{0.081 (L_i + n)^{3.23}}{(\overline{SN} + 1)^{5.19} (n^{3.23})} \quad (\text{A1.5})$$

$$\beta_{18,1} = 0.40 + \frac{1094}{(\overline{SN} + 1)^{5.19}} \quad (\text{A1.6})$$

where:

$LEF_{L,n}$ = Load Equivalence Factor; the number of 18 000-lb single-axle load applications that will have an equivalent effect upon pavement serviceability as one application of a load L_i on a type n axle for the given flexible pavement structural number $\overline{SN}$ and terminal serviceability

L_i = load i on the axle set (type) under consideration, lb/1000,

n = axle-type code: 1 for a single axle, 2 for a tandem-axle set, or 3 for a triple-axle set, (Support for using $n = 3$ to calculate LEFs for triple-axle sets is presented in *AASHTO 1986, Vol 2, Appendix MM*, see 2.2.),

G_t = see (Eq A1.3).

A1.2.3 Calculation of AASHTO ESALs—Equivalent Single Axle Loads (ESALs), by AASHTO's concept, are the cumulative number of applications of an 18 000-lb single-axle load (a common denominator) that will have an equivalent effect on pavement serviceability of a specified pavement structure as all applications of various axle loads and types by vehicles in a mixed-traffic stream. AASHTO ESALs are determined by calculating the LEF for each axle set on all vehicles in a measured or assumed mixed-traffic stream according to its axle type (single, tandem, triple) and magnitude of load for a defined pavement structure and terminal serviceability, and summing the LEFs. The LEF calculated for a single axle is applicable only to nonsteering axles and to single-tire single axles on two-axle vehicles loaded to 2000 lb or less, as the regression equations developed from analysis of the AASHTO Road Test data are based only on such axles. The damaging effect of the steering (front) axles, with single tires, on the test trucks was not evaluated separately, but instead was incorporated into the effects resulting from the other axles on the test trucks, called load axles. The regression coefficients in the AASHTO design equations are sensitive to the units of measurement for load; therefore, AASHTO ESALs must be calculated only in U.S. customary units.

A1.3 AASHTO Axle Load Equivalence Factors and ESALs for Rigid Pavements

A1.3.1 AASHTO Design Equations—The design equations for rigid pavements presented in the *AASHTO Interim Guide for Design of Pavement Structures, 1972, Appendix D, Revised 1981* (see 2.2), are:

$$\log W_t = 5.85 + 7.35 \log (D + 1) - 4.62 \log (L_1 + L_2) + 3.28 \log L_2 + \frac{G_t}{\beta} \quad (\text{A1.7})$$

$$\beta = 1.0 + \frac{3.63(L_1 + L_2)^{5.20}}{(D + 1)^{8.46} L_2^{3.52}} \quad (\text{A1.8})$$

$$G_t = \log \left[\frac{4.5 - p_t}{4.5 - 1.5} \right] \quad (\text{A1.9})$$

where:

D = thickness of rigid pavement slab, in.

All other terms in these equations are as defined in A1.2.1.

A1.3.2 Calculation of AASHTO LEFs—The design equation (Eq A1.7) for rigid pavements can be arranged into a ratio format and solved to calculate a load equivalence factor. The number of applications of an 18 000-lb single-axle load $W_{t,1}$ that is expected to cause an equivalent change in serviceability to a rigid pavement with the same slab thickness D and terminal serviceability p_t as one application $W_{t,n} = 1$ of an axle load under consideration L_i and axle type n is called the Load Equivalence Factor, $LEF_{L_i,n}$. This load equivalence factor can be calculated by solving the following equations. (6)

$$LEF_{L_i,n} = \frac{W_{t,1}}{W_{t,n}} = \left[\frac{(L_i + n)^{4.62}}{(18 + 1)^{4.62}} \right] \left[\frac{10^{G_t/\beta_{t,1}}}{(10^{G_t/\beta_{t,n}})(n^{3.52})} \right] \quad (\text{A1.10})$$

$$\beta_{L_i,n} = 1.0 + \frac{3.63(L_i + n)^{5.20}}{(D + 1)^{8.46} (n^{3.52})} \quad (\text{A1.11})$$

$$\beta_{18,1} = 1.0 + \frac{1.620 \times 10^7}{(D + 1)^{8.46}} \quad (\text{A1.12})$$

where:

$LEF_{L_i,n}$ = Load Equivalence Factor; the number of 18 000-lb single-axle load applications that will have an equivalent effect upon pavement serviceability as one application of a load L_i on a type n axle for the given rigid pavement slab thickness D and terminal serviceability p_t .

D = thickness of rigid pavement slab, in.

L_i = load i on the axle set (type) under consideration, lb/1000,

n = axle-type code: 1 for a single axle, 2 for a tandem-axle set, or 3 for a triple-axle set, (Support for using $n = 3$ to calculate LEFs for triple-axle sets is presented in *AASHTO 1986, Vol 2, Appendix MM*, see 2.2.),

G_t = see (Eq A1.9).

A1.3.3 Calculation of AASHTO ESALs—See A1.2.3.

REFERENCES

- (1) "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices," *National Institute of Standards and Technology (NIST) Handbook 44*, U.S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328, ISBN 0-16-049313-7.
- (2) *Traffic Monitoring Guide, Third Edition*, February 1995, U.S. Department of Transportation, Federal Highway Administration, Office of Highway Information Management, Washington, DC 20590.
- (3) Highway Research Board, "The AASHTO Road Test," Report 5, Pavement Research, *Highway Research Board Special Report 61E*, 1962.
- (4) Highway Research Board, "The AASHTO Road Test," Proceedings of a conference held May 16-18, 1962, St. Louis, Missouri, *Special Report 73*, Washington, DC 1962.
- (5) Halvorsen, Don, "Finger on the Pulse, Piezos on the Rise," *Traffic Technology International*, UK & International Press, Abinger House, Church Street, Dorking, Surrey RH4 1DF, UK, ISSN 1356-9252, June/July 1999, pp. 52-57.
- (6) Highway Research Board, "Evaluation of AASHTO Interim Guides for Design of Pavement Structures," *National Cooperative Highway Research Program Report 128*, 1972, p. 20.
- (7) Carmichael III, R.F., Roberts, F.L., Jodahi, P.R., Treybig, H.J., and Finn, F.N., "Effects of Changes in Legal Load Limits on Pavement Costs: Volume 1—Development of Evaluation Procedure," *Federal Highway Administration Report No. FHWA-RD-78-98*, July 1978.

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35. Communications Tower, Item SPV.0105.09.

A Description

This special provision describes the design and general construction work for the SWEF communications tower. The work includes the concrete base, monopole, cabling, transmission line bridge, ground grid, building entry and associated equipment. The work shall be in accordance with the applicable plans and the following specifications.

B General

SECTION 02010 – Subsurface Investigation

The project Geotechnical Report may be obtained from Robert Spoerl, WisDOT Roadside Facilities Engineer, telephone (608) 266-8665, or by email robert.spoerl@dot.state.wi.us.

The soil-boring log of boring 05-07, taken for the Communications Tower, is shown as follows.



CPH Engineering, Inc.

SOIL BORING LOG

Project Name: **PROPOSED MADISON SWEF**
 Location: **Dane County, Wisconsin**
 (H) Project No.: **05G-120**

Test Boring No: **05-07**
 Ground Surface EL: **295.9**
 Test Boring Depth: **47.5'**
 Boring Start Date: **April 18, 2005**
 Boring End Date: **April 18, 2005**
 Field Representative: **Chris Mallon**
 Driller: **Soils & Engineering**
 Drilling Method: **2 1/2" HSA 0 to 47.5' (AH)**

VISUAL SOIL CLASSIFICATION	DEPTH (feet)	SAMPLE No.	Blow Counts	N Value	Cu (psf)	MC (%)	Qp (tsf)	P200 (%)	C	Unit Wt (pcf)	REMARKS
12" Topsoil											
SILTY SAND, tan, moist, medium dense (SM) (A-2-4)		1 - SS	4/6/8	14							
[OUTWASH]	5	2 - SS	13/6/5	11							5
LEAN CLAY, with Gravel, grayish brown, moist, medium stiff (CL) (A-6)		3 - SS	4/5/8	13	6,200	19			3,100	104	
[LACUSTRINE]											
SILTY SAND, brown, moist, medium dense (SM) (A-2-4)	10	4 - SS	5/7/8	15		15					10
[OUTWASH]		5 - SS	4/5/6	11							
LEAN CLAY, with Gravel, grayish brown, moist, medium stiff (CL) (A-6)	15	6 - SS	5/5/5	10	3,500	24			1,750	94	15
[LACUSTRINE]											
SILTY SAND, tan, moist, medium dense to dense (SM) (A-2-4)	20	7 - SS	4/8/9	17		12					20
[OUTWASH]											
	25	8 - SS	4/7/12	19							25
	30	9 - SS	7/9/12	21							30
SAND, with Silt and Gravel, brown, moist, extremely dense (SP) (A-1-b)	35	10 - SS	100/5"	100/5"							35
[OUTWASH]											
	40	11 - SS	100/3"	100/3"							40
		12 - SS	100/2"	100/2"							

Lines of Demarcation represent an approximate boundary between soil types. Variations may occur between sampling intervals and between boring locations, and the transition may be gradual. Dashed lines are indicative of potentially erratic or unknown changes, such as fill-to-natural soil zone transitions.



CPH Engineering, Inc.

SOIL BORING LOG

Project Name: **PROPOSED MADISON SWEF**
 Location: **Dane County, Wisconsin**
 (H) Project No.: **05G-120**

Test Boring No: **05-07B**
 Ground Surface EL: **295.9**
 Test Boring Depth: **47.5'**
 Boring Start Date: **April 18, 2005**
 Boring End Date: **April 18, 2005**
 Field Representative: **Chris Mallon**
 Driller: **Soils & Engineering**
 Drilling Method: **2 1/2" HSA 0 to 47.5' (AH)**

VISUAL SOIL CLASSIFICATION	DEPTH (feet)	SAMPLE No.	Blow Counts	N Value	Cu (psf)	MC (%)	Qp (tsf)	P200 (%)	C	Unit Wt (pcf)	REMARKS
SAND, with Silt and Gravel, brown, moist, extremely dense (SP) (A-1-b) [OUTWASH]											
50 TERMINATION DEPTH OF BORING: 47.5' AUGER REFUSAL AT 47.5'	50										50
55	55										55
60	60										60
65	65										65
70	70										70
75	75										75
80	80										80
85	85										85
 Water During Drilling  Water Level Upon Completion  Water Level After 3 Hours											

Lines of Demarcation represent an approximate boundary between soil types. Variations may occur between sampling intervals and between boring locations, and the transition may be gradual. Dashed lines are indicative of potentially erratic or unknown changes, such as fill-to-natural soil zone transitions.

SECTION 02370 - DRILLED CONCRETE PIERS

This section provides information common to two or more technical site work specification sections or items that are of a general nature, not conveniently fitting into other technical sections. This section applies to DRILLED PIERS (Drilled Shafts, Caissons or Bored Pile Foundations), as applicable.

Included are the following topics:

PART 1 - GENERAL

1. Scope
2. Definitions
3. Related Work and Provisions
4. Reference Standards
5. Submittals
6. Project Conditions
7. Quality Assurance
8. Codes
9. Certificates and Inspections

PART 2 - PRODUCTS

1. General
2. Steel Casing
3. Reinforcing Materials
4. Accessory Materials
5. Concrete Materials
6. Admixtures
7. Slurry Properties

PART 3 - EXECUTION

1. Excavation of Shaft
2. Tolerances
3. Reinforcement Placement
4. Placement of Concrete
5. Cold Weather Placement
6. Hot Weather Placement
7. Concrete Finishes
8. Curing
9. Protection
10. Repairing and Patching
11. Field Quality Control

PART 1 - GENERAL

1. Scope

The work under this section shall consist of providing all work, materials, labor, equipment, and supervision necessary to perform the work on the site as provided for in the technical specifications and on the drawings.

Work on the Madison SWEF Communications Tower shall conform to all requirements of ACI 336-97 Reference Specifications for the Construction of Drilled Piers, published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by the requirements of these Contract Documents.

This project and specification deals with the design and construction of foundations made of reinforced concrete. Its scope is limited to piers constructed by digging, drilling or otherwise excavating a hole in the soil which subsequently is filled with concrete, and does not include rectangular piers on spread footings in deep excavations. Installation without excavation, by methods such as mortar intrusion, mixed-in-place, and similar procedures are not considered applicable for this project.

2. Definitions

Owner- State of Wisconsin, Department of Transportation, Bureau of Communications, Division of State Patrol

Owner's Representative – For this project the State of Wisconsin, Department of Transportation, Division of Transportation System Development, Project Engineer

3. Related Work & Provisions

This section relates to all Division 2 sections as they pertain to site work and to Division 3 sections as they pertain to concrete work.

Applicable provisions of Division 1 shall govern all work under Division 2 and Division 3 of the specifications.

4. Reference Standards

Comply with all provisions of the following codes and standards except as modified herein.

All referenced codes and standards including all revisions and commentaries shall be the most currently adopted as of the date of these contract documents.

Abbreviations of standards or organizations referenced in this specification are as follows:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI Building Code Requirements for Reinforced Concrete

Comply with all ACI Standards including Sections 211, 301, 302, 304, 304, 305, 306, 308, 311, 336, 347.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 Structural Welding Code - Steel

AWS D1.4 Structural Welding Code - Reinforcing Steel

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A-36 Specification for Structural Steel
- A-496 Specification for Deformed Steel Wire for Concrete Reinforcement
- A-615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A-706 Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
- C-33 Specification for Concrete Aggregates
- C-109 Test Method for Compressive Strength of Hydraulic Cement Mortars
- C-150 Specification for Portland Cement
- C-171 Specification for Sheet Materials for Curing Concrete
- C-260 Specification for Air-Entraining Admixtures for Concrete
- C-494 Specification for Chemical Admixtures for Concrete

Comply with ASTM Standards including Sections A82, A185, A775, C31, C39, C94, C143, C172, C231, C309, D175.

Concrete Reinforcing Steel Institute (CRSI)

Manual of Standard Practice

Recommended Practice for Placing Reinforcing Bars

Deep Foundations Institute: DFI-ADSC Drilled Shaft Inspections Manual

ADSC: The International Association of Foundation Drilling:

DFI-ADSC Drilled Shaft Inspectors Manual

ADSC Down-Hole Entry Manual

ADSC-FHWA The Effects of Free Fall Concrete in Drilled Shafts

Federal Highway Administration:

FHWA-RD-92-004 Drilled Shafts for Bridge Foundations

International Building Code and Wisconsin Enrolled Commercial Building Code

Supplier is responsible for obtaining State of Wisconsin Department of Commerce approval for products being supplied prior to fabrication.

5. Submittals

Shop Drawings - Refer also to Section GC - General Conditions of the Contract

The Contractor shall submit shop drawings prior to fabrication that show sizes and dimensions for fabrication and placing of reinforcing steel and bar supports. Indicate bar schedules, stirrup spacing and diagrams of bent bars, arrangements, lap lengths and assemblies.

6. Project Conditions

Subsurface Investigation; Contractor shall review results of the subsurface investigation as presented in Section 02010 of the Contract Documents.

7. Quality Assurance

Substitution of Materials: Refer to Section GC - General Conditions of the Contract.

The Engineer shall be notified upon completion of the shaft excavation and will determine the acceptability of the excavation prior to placement of reinforcement and concrete fill.

8. Codes

Comply with the requirements of International Building Code and Wisconsin Enrolled Commercial Building Code whenever applicable.

9. Certification And Inspections

Refer to Section GC - General Conditions.

Obtain and pay for all required sampling, testing, inspections and certifications except those provided by the Engineer. Deliver originals of certificates and documents to the Division's construction representative.

PART 2 - PRODUCTS

1. General

This Section covers minimum general requirements for materials and products in connection with construction of the drilled pier.

Final design of the drilled pier tower support foundation shall be the responsibility of the Tower Contractor and his engineer.

2. Steel Casing

Permanent steel casing is not part of the proposed shaft structure and is not shown on the project drawings.

Temporary steel casing required by field conditions may be required, but is not shown on the project drawings. If required temporary casing shall have sufficient wall thickness and strength for handling stresses and to resist all soil and water pressures. Temporary casing provided by the Contractor, as required, will be at no additional cost to the Owner.

3. Reinforcing Materials

Billet Steel: ASTM A615, Grade 60 for all reinforcing. Minimum grade.

4. Accessory Materials

Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place: Provide spacer rollers to maintain clear cover between reinforcement cage and pier excavation.

For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with plastic protected legs or similar spacers.

Embedded fabricated tower anchor bolts and fabricated template(s) shall be hot dipped galvanized per ASTM A153.

5. Concrete Materials

Use concrete and concrete work conforming to ACI 301, particularly Sections 1, 4 and 5.

The minimum 28-day concrete strength shall be 4500 psi, maximum aggregate size $\frac{3}{4}$ inches, minimum slump of 5 to 6 inches and 6% air-entraining admixture.

Portland Cement: For normal concrete, ASTM C150, Type I or Type II. Use only one brand of cement throughout the project.

Aggregates: Conform to ASTM C33. Coarse aggregates shall not contain more chert and other deleterious substances than allowed by Table 3 in ASTM C 33.

Fine Aggregate: Natural sand.

Coarse Aggregate: Crushed stone or gravel for structural concrete.

Grout: Cement grout conforming to ASTM C 845-76T, Compensation for shrinkage.

Water: Clean, fresh, free from oil, acid, organic matter or other deleterious substances.

6. Admixtures

Air-Entraining: ASTM C 260.

Water-Reducing: ASTM C496, Type A, "Pozzolith 220-N" by Master Builders or approved equivalent.

Water-Reducer/Retarder: ASTM C 494, Type D, Pozzolith 100-XR" by Master Builders or approved equivalent

Super Plasticizer: ASTM C 494, Type F, "WRDA-19" by Grace or approved equivalent.

Fly Ash: ASTM C 618 C.

Calcium Chloride (or admixtures containing calcium chloride): Not permitted.

7. Slurry Properties

As required per Table 2.6 of ACI 336.

PART 3 - EXECUTION

1. Excavation Of Shaft

Off site disposal of soil excavated from the foundation shaft will be required at no additional cost to Owner.

The minimum amount of loose material or water at the base of excavation permissible in the drilled shaft at time of concrete placement shall not exceed two (2) inches.

Depth of shaft shall be based upon Tower Contractor's design with approval of the Engineer upon completion of the shaft excavation.

Provide minimum shaft diameter shown on the project drawings or larger as designed by the Tower Manufacturer. Diameters larger than shown on the drawings shall be submitted to the Engineer for approval.

Tower Contractor's design engineer shall determine final depth of pier foundation and determine actual final bearing levels during excavation. Bottom elevation of drilled pier shown on project drawings is based upon the geotechnical report and is an estimated depth for bid purposes. The unit price requested in the bid form is for greater or lesser foundation depth and will be used as a unit add or deduct price for above and below design foundation depth. No adjustment in unit price will be made for foundation diameters larger than that indicated on the drawings.

2. Tolerances

Use tolerances in accordance with ACI 117 except as noted below.

Forms shall conform to the shape, lines and dimensions as called for on the drawings and shall be substantially tight to prevent leakage of mortar. Provide $\frac{3}{4}$ inch chamfers at all exposed concrete edges.

Set and build into the work anchorage devices and other embedded items required for the 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.

3. Reinforcement Placement

Provide reinforcement per the Tower Contractor's design.

The reinforcement steel shall be designed as a structural element and braced to retain its configuration throughout the placed of concrete and extraction of the casing from the shaft if used.

Install reinforcement in strict conformance with approved shop drawings and all CRSI recommendations.

Notify the engineer at least 24 hours in advance of concrete pours to enable their review of reinforcement in place prior to concrete placement.

Tend to reinforcing at all times during concrete placement and make necessary adjustments to reinforcing and other embedded items which have been dislodged by concrete placement or workmen.

4. Placement Of Concrete

No water shall be added to batch mix at the building site.

Place all concrete in accordance with ACI 304 Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete and ACI 304.2R Placing Concrete by Pumping Method.

Free fall of concrete placement will be allowed in dry excavations and at depths less than 50 feet. Avoid hitting the reinforcement cage upon placement of concrete.

Placement of concrete by tremie method or pumping may be used.

5. Cold Weather Placement

When winter construction is anticipated, the Contractor is expected to continue to pour concrete during normal winter weather conditions.

Protect concrete work from physical damage or reduced strength which may be caused by frost, freezing actions or low temperatures with ACI 306 Recommended Practice for Cold weather Concreting.

Do not place concrete during any day when the mean daylight temperature is less than 20° F.

Do not place concrete during inclement weather conditions, for example during rain, snow or hail.

6. Hot Weather Placement

When weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 Recommended Practice for Hot Weather Concreting. Do not place concrete when the air temperature is above 90° F.

During hot weather or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.

7. Concrete Finishes

Float and Broom Finish: Exposed surfaces and provide 3/4-inch chamfer on exposed edges.

8. Curing

MOIST CURING

All exposed surfaces shall be cured per ACI 308 2.3.1 Plastic Film or 2.3.2 Reinforced Paper only for 7 days after placement. Curing system shall be sealed and moisture added daily to maintain concrete surface in a damp condition. Insulating blankets used during cold weather do not need sealed joints as long as concrete surface is damp. After 7 days of moist curing, apply liquid membrane system.

9. Protection

Protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

10. Repairing And Patching

Comply with ACI 301 – Specifications for Structural Concrete for Buildings.

Remove and replace at no cost to the owner all concrete not formed as indicated, concrete out of alignment, surfaces exceeding tolerances or defective surfaces which cannot be repaired or patched. Include concrete failing to meet strength requirements as reported the testing laboratory.

Clean, dampen and fill all bolt, tie holes, poor joints, voids, honeycombs and other similar defects with patching concrete immediately after removing forms. Remove all fins.

11. Field Quality Control

General: Test all concrete in the manner specified below:

Specific Tests, Inspections and Methods Required.

Testing: Slump and air content tests shall be made at the option of the owner's project representative to substantiate mix designs.

Perform slump tests in accordance with ASTM C 143 and air content tests in accordance with C 231.

Test Cylinders: Cylinders for strength test shall be made according to ASTM C 31. Each test shall consist of a minimum of three cylinders. One tested at 7 days and two cylinders at 28 days.

Strength test shall be made for each day's pour, each class of concrete, each change of supplier and for each 100 cubic yards of concrete.

The engineer may waive testing requirements after consistency has been shown.
END OF SECTION 02370

SECTION 02780 - Tower

This section provides information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. This section applies to ALL the communications tower structure and all supporting elements, as applicable.

Included are the following topics:

PART 1 - GENERAL

1. Scope
2. Summary of Work Included
3. Related Work and Provisions
4. Reference Standards
5. Design
6. Quality Assurance
7. Equipment and Materials Furnished by Others
8. Submittals
9. Warranty
10. Certificates and Inspections
11. Operating and Maintenance Instructions
12. Training of Owner Personnel
13. Record Drawings

PART 2 - PRODUCTS

1. Materials
2. Obstruction Lighting
3. Painting
4. Special Conditions

PART 3 - EXECUTION

1. General
2. Erection of Tower
3. Completion of Project

PART 1 -GENERAL

1. Scope

The work under this section includes minimum requirements for the analysis, design, fabrication and erection of a free standing steel monopole tower and drilled pier support foundation which will be a part of the point-to-point communications system as provided for in the technical specifications and on the drawings.

The tower shall be capable of holding all antennas shown on Drawing SP-2. Design loading criteria is covered later in this section.

All work shall be in accordance with applicable manufacturer's instructions.

2. Summary Of Work Included

The contractor shall provide personnel and equipment to install the antennas and lines listed on sheet SP-2 of the drawings. All transmission lines associated with the dish antennas shall be EW63 or equivalent, all other transmission lines shall be 1 5/8-inch jacketed coax. Transmission lines shall be installed within the monopole structure through entry/exit ports and hand holes. The contractor shall install all hoist grips, two grounding kits per line, plus associated rigging and tagging.

Contractor shall provide hardware for attachment of hoist grips to the tower as required.

Contractor shall align the dish antenna(s) when installation is complete. For the alignment, the contractor shall furnish personnel for each end of the path under alignment.

There will be (1) one alignment path; the path will have 2 dishes, one at each end: Madison SWEF site to Deerfield site, azimuth $\pm 68^\circ$

The contractor shall provide mounting brackets for all antenna indicated on Drawing SP-2. Mounting bracket for each parabolic antenna shall be 4½-inches (outside diameter) pipe, and for whip type antennas shall be 2-inches (outside diameter minimum) pipe with all materials to mount the pipe to the tower. Brackets shall be installed at specified heights and shall be designed so that unit stresses resulting from specified loads do not exceed allowable stresses of the "Specification for Structural Steel Buildings – Allowable Steel Design and Plastic Design" issued by the American Institute of Steel Construction.

The contractor shall design and provide antenna supports as indicated on Drawing SP-2 and provide entry/exit ports and hand holes for installation of waveguide and coax cables within tower structure.

Sidearm antenna supports shall be designed and layout in a manner indicated on the drawings with adequate bracing to prevent distortion and antenna strikes during wind gusts.

The contractor shall furnish and install a waveguide bridge (outside cable tray) and associated supports and foundations from the tower to the adjacent building. Bridge shall be provided with ice shield, and shall be sized to accommodate all transmission lines shown on Drawing SP-2. Cable bundling is not permitted. Waveguide bridge shall be bonded to tower, buried ground grid and existing interior building ground bus.

The engineer shall approve the contractor's proposed grounding system at the tower base location prior to installation.

All antennas, lines and associated hardware provided by owner will be located at the Wisconsin State Patrol Radio Shop, Dane County Airport, Madison, Wisconsin. The

Contractor is responsible for transportation of this equipment from this location to the job site.

The contractor shall be responsible for cleanup of the site of all refuse associated with this contract. Contractor to remove all crates, reels and other refuse associated with the antennas and line shipping.

3. Related Work And Provisions

This section relates to all Division 2 and Division 3 and other applicable Division sections as they pertain to the tower structure.

This specification shall apply to all tower structure work unless otherwise specified. Refer to Section 02370 – Drilled Concrete Piers, relative to the tower foundation work.

Applicable provisions of Division 1 shall govern all work under Division 2 and 3, and all Division 2 and 3 specifications.

4. Reference Standards

Abbreviations of standards or organizations referenced in this specification are as follows:

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISC	Manual of the American Institute of Steel Construction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CS	Commercial Standards, Products Standards Sections, Office of Eng. Standards Service, NBS
EPA	Environmental Protection Agency
EIA	Electronic Industries Association
FS	Federal Specifications, Superintendent of Documents, U.S. Government Printing Office
UL	Underwriters Laboratories Inc.
IEEE	Institute of Electrical and Electronics Engineers
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
TIA	Telecommunications Industry Association

Where reference is made to the "standard specifications", it shall be construed to mean the pertinent sections of the State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction (SSHSC), current edition, and all supplemental and interim supplemental specifications, as they may pertain.

5. Design

The tower shall be designed, fabricated and erected in accordance with TIA/EIA-222-F Standard, including the latest revisions. Comply with EIA Specifications for twist and sway as they relate to the tower and antenna support brackets.

The design, fabrication and erection shall conform to the requirements of the Federal Communications Commission, Federal Aviation Administration, Wisconsin Department of Aeronautics, the National Electrical Code, International Building Code and Wisconsin Enrolled Commercial Building Code.

For this project the tower shall be designed for 90 MPH (fastest-mile) wind load. Tower shall conform to TIA/EIA RS-222-F, latest revisions. Calculations shall include ½ inch radial thickness of ice coating on all members of the structure.

Analysis and design shall include ½-inch radial thickness of ice coating on all members of the structure. When this ice loading is considered, the wind load shall be reduced 25 percent when considered to occur simultaneously with ice (equivalent to 87 percent of the basic wind speed). Wind loads shall be considered basic design loads with no increase in allowable unit stress permitted.

Any known conflicts between these specifications or drawings, and codes, as well as any suspected error in these specifications or plans shall be brought to the attention of the engineer.

Design analysis, erection drawings and foundation drawings shall be certified by a Registered Professional Engineer licensed in the State of Wisconsin.

Tower foundation shall be designed to match the soil conditions provided in the subsurface soil exploration report. Refer to Section 02010 - Subsurface Investigation. If subsurface conditions are found to be materially different from those described, then the provisions of Article 2, General Requirements shall apply. Refer to Section 02370 – Drilled Concrete Piers for specific foundation requirements.

All components of the tower and support elements shall be designed so that the unit stressed resulting from specified loads shall not exceed the allowable stresses of the “Specification for the Design, Fabrication and Erection of Structural Steel Buildings” issued by the American Institute of Steel Construction. However, wind loads shall be considered basic design loads with no increase in allowable unit stress permitted.

6. Quality Assurance

Substitution of Materials: Refer to Section GC - General Conditions of the Contract.

Where equipment, accessories, or materials are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated in the contract documents, the contractor is responsible for all costs involved in integrating the

equipment or accessories into the system and for obtaining the intended performance from the system into which these items are placed.

All ground and aerial work shall be performed by persons equipped and qualified to do so. The contractor shall furnish, upon award of tower contract, evidence of adequate bonding and insurance to hold the State harmless in completion of the contract issued for this work.

The contractor shall be experienced in the installation and alignment of microwave parabolic antennas. Furnish a list of at least three references where microwave parabolic antennas were installed and aligned.

The contractor shall visit the tower site to verify the site specific data and drawings, Any expense and delay due to lack of information shall be the contractor's responsibility.

The contractor shall be responsible for the engineering, fabrication, delivery and installation of the tower and tower foundation as described on site-specific data sheets and the following specifications.

7. Equipment And Materials Furnished By Others

Owner shall furnish all antenna and mounting hardware for attachment to three (2) inch diameter mounts. The owner shall furnish the dish antenna and dish mounting brackets for attachment to a 4 ½-inch outside diameter pipe. Owner will install the connections on the coax and waveguide.

The owner will furnish the hoist grips and coax waveguide hangers plus the hanger mounting bolts.

The owner will furnish stainless steel clamps and attachment hardware for the transmission lines.

8. Submittals

Refer also to Section GC - General Conditions of the Contract.

Submit manufacturer's preproduction (shop) drawings for any offsite constructed sitework items for approval prior to the start of manufacturing.

All submittals must receive full approval of the engineer prior to tower manufacture and erection.

Four additional copies of all design analysis and material certification, approval information shall be provided the user agency (Department of Transportation, Division of State Patrol, Bureau of Communications) for their records.

The plans submitted to the engineer shall include a site plan and drawings showing tower configuration and foundation, (4) four copies of submittal are required. Submittal of

calculations showing that the foundation will resist over-turning and applied horizontal forces are also required.

DRAWINGS

The following drawings shall be submitted to the engineer for approval prior to fabrication of the tower:

- a. Cover sheet showing station name, tower height, manufacturer's name and model number;
- b. Elevation and plan view showing tower orientation. Precise antenna/reflector location and bearings, light levels as required, plus any pertinent notes.
- c. Tower base foundation and associated concrete reinforcement details, plan and elevation views. Drawing shall include such information as reinforcement bar size, quantity and position, cubic yards of concrete, concrete finishing techniques, grounding details and other pertinent information.
- d. Tower section drawings showing all tower members, splice plates, antenna supports, entry/exit ports and hand holes, and any other information needed to identify each portion of the tower. Show dimensions of all tower members including the location and size of each bolt hole.
- e. Drawing showing tower base details and hardware details.
- f. Drawing showing transmission line bridge and associated supports.
- g. Drawing of miscellaneous details such as antenna mounting, permanent climbing rungs, waveguide position and mounting details.

Four (4) additional copies of all drawings and information shall be furnished to the user agency (Department of Transportation, Division of State Patrol, Bureau of Communications) for record files.

STRUCTURAL ANALYSIS

Submittal requirements: A complete and detailed structural analysis shall be performed on the proposed tower structure. Tower supplier shall submit all input parameters and calculations used to determine the stresses, proportion the members and design the connections of the tower support elements. Design safety factor valves shall be supplied.

Minimum requirements: Tower shall be analyzed per TIA/EIA-222-F, latest revision.

9. Warranty

The tower supplied under this specification shall be warranted to be free of defects for a minimum period of five (5) years from the date of substantial completion. Tower defects in materials or workmanship during this period and any materials and equipment damage because of defects, shall be repaired or replaced at no cost to the owner.

This warranty shall **not** be void by the owner's use of other competent Contractors to install antennas or transmission lines on the tower when the work is consistent with the initial design and acceptable to the owner.

Warranty service shall be provided and repairs completed within 24 hours following notification of contractor by owner that a failure covered by the warranty provisions has occurred. Contractor shall furnish owner with a telephone number at which contractor, or his representative, may be reached 24 hours a day, seven days a week, notification of in-warranty failures.

10. Certifications And Inspections

Refer to Section GC - General Conditions.

Obtain and pay for all required sampling, testing, inspections, and certifications except those provided by the engineer. Deliver originals of certificates and documents to the Division's construction representative. Include copies of the certifications and documents in the Operating and Maintenance Instructions.

11. Operating And Maintenance Instructions

Refer to Section GR - General Requirements.

Assemble material in an operating and maintenance manual composed of three-ring or post binders, using and index at the front of each volume and tabs for each system or type of equipment installed. In addition to the data indicated in the General Requirements, include the following information:

- a. Copies of all approved shop drawings
- b. Records of tests performed to certify compliance with system requirements
- c. Parts lists for manufactured equipment
- d. Warranties and/or guarantees
- e. Additional information as indicated in the technical specification sections

12. Training Of Owner Personnel

Instruct owner personnel in the proper operation and maintenance of systems and equipment provided as part of this project. Include instruction, using the Operating and Maintenance manual during this instruction. All training to be done during normal work hours.

13. Record Drawings

Refer to Section GR - General Requirements.

Maintain and provide record drawings of all as-built system installations and points of connection made as part of this project. Include copies of record drawings with the Operating and Maintenance instructions.

PART 2 - PRODUCTS

1. Materials

Materials shall be per TIA/EIA-222-F.

All structural materials and fabricated parts shall be galvanized in accordance with ASTM A-123 (Hot-Dip). Including but not limited to the monopole structure, antenna supports, ice bridge and associated hardware.

Tower shall be designed and fabricated so that erection may be accomplished using bolts with no field welding required.

All hardware shall be hot dipped galvanized in accordance with ASTM 153. Including but not limited to antenna support assemblies, access ports, ladder rungs and associated assemblies.

The tower shall be equipped with permanent climbing ladder rungs outside the tower structure.

Furnish and install a safety-climb cable system for monopole towers that meets or exceeds OSHA and ANSI requirements for climbing safety, complete with safety harness.

Furnish and install hand holes and two access ports at tower base as shown on the project drawings.

Each mount standoff support assembly shall be braced back to tower structure to minimize deflections of the antenna such that pole type antenna assemblies do not strike one another or the tower structure under the design basic wind speed.

Support of transmission cables beneath ice bridge between tower and equipment building, provide extended double T-line brackets similar to Pirod/Valmont Model 802176 with ¾-inch holes. Minimum three (3) feet on-center, or as recommended by the cable manufacturer.

Furnish and install transmission line support and ice bridge supported by galvanized steel pipes between tower and building cable entry. At least three (3) of the pipe supports shall be four (4) inches in diameter schedule 40 steel pipe and extend four (4) feet above top of transmission cable ice fall protection.

Provide two ground tabs at the base of the tower: two ¼-inch thick by 4-inch by 4-inch steel ground tabs for use in attachment of ground conductors.

Furnish and install two copper ground bus bars (one for each access port) near tower base access ports for grounding transmission cables. Copper bus bars shall be for 15 two-hole grounding lugs, minimum copper bar size ¼-inch x 2-inch x 14-inch (Valmont Communications Part No. B2983 or equivalent). Mount copper ground bus on exterior of tower, but under no circumstance shall copper bar contact galvanized steel tower structure. Provide non-conductive insulator between bus bars and tower structure.

2. Obstruction Lighting

None required.

3. Painting

None Required. Tower structure finish and associated ports, antenna supports shall be galvanized coating in accordance with ASTM A123.

Damage to galvanized coating occurring during transit or erection shall be promptly and properly repaired on site.

4. Special Conditions

The contractor shall confirm that the owner has a valid FAA construction permit before commencing construction.

PART 3 - EXECUTION

1. General

The contractor shall designate an employee responsible for all OSHA job safety requirements. The individual shall be on site at all times and have full authority to make safety changes.

Workmanship shall be of the best quality. All work shall be carefully and accurately performed. All members shall be straight and true to the drawings. The blocking, punching, clipping, bending and welding shall be accurately done so that no drifting is necessary in assembly.

Contractor shall protect all building(s), paved surfaces, landscaping and HVAC equipment during the construction of the tower foundation and erection of the tower. Contractor shall be liable for any damage caused to such building, structure and equipment.

2. Erection Of Tower

The tower shall be designed and fabricated so that erection may be accomplished using bolts with no field welding required.

All bolts shall have a minimum of two (2) threads protruding beyond the nut.

The contractor shall make the connection (bond) between #2 tinned solid copper wire ground conductors and tower base, transmission line bridge and existing cable transmission line structure.

3. Completion Of Project

The contractor shall, in the presence of the engineer, conduct a complete demonstration of the system performance.

A complete mechanical inspection of the system shall be conducted to verify compliance with the requirements of these specifications. Project acceptance will be made only after all the following conditions have been met:

- a. The contractor has supplied and installed all equipment specified herein;
- b. All discrepancies noted in the performance inspection and mechanical inspection have been corrected;
- c. Contractor has supplied two (2) copies of “record” drawings and two (2) bound sets of equipment maintenance, operation manuals and warranty documents;
- d. All debris, tools, packing cases, etc., have been removed from the site by the contractor, and;
- e. Owner’s technical personnel have been fully instructed in the proper operation, maintenance and repair of the system.

END OF SECTION 02780

SECTION 16170 - Grounding And Bonding
BASED ON DSF MASTER ELECTRICAL SPEC DATED 6/02/03

Grounding electrodes and conductors, equipment grounding conductors and bonding. Included are the following topics:

PART 1 - GENERAL

1. Scope
2. Related Sections
3. References
4. Grounding Electrode System
5. Performance Requirements
6. Submittals
7. Project Record Documents
8. Qualifications
9. Regulatory Requirements

PART 2 - PRODUCTS

1. Rod Electrode
2. Mechanical Connectors
3. Compression Connectors
4. Exothermic Connections
5. Wire
6. Bus

PART 3 - EXECUTION

1. Examination
2. General
3. Less Than 600-Volt System Grounding
4. Field Quality Control

PART 1 - GENERAL

1. Scope

Applicable provisions of Division 1 shall apply to all work under this Section.

2. Related Sections

Section 02780 - Tower

3. References

NFPA 70 - National Electrical Code.

ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

4. Grounding Electrode System

Ground grid system composed of buried ground wires, rod electrodes to be bonded to the tower structure.

5. Performance Requirements

Grounding System Resistance: 2-ohms maximum at building service entrance..

6. Submittals

Submit under the provisions of Division 1, General Conditions of the Contract, and Section 16010.

Product Data: Provide data for grounding electrodes and connections.

Test Reports: Indicate overall resistance to ground [and resistance of each electrode].

Manufacturer's Instructions: Include instructions for preparation, installation and examination of exothermic connectors.

7. Project Record Documents

Submit record documents under provisions of Division 1 and Section 16010.

Accurately record actual locations of grounding electrodes.

8. Qualifications

Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years documented experience.

9. Regulatory Requirements

Conform to requirements of NFPA 70.

Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 - PRODUCTS

1. Rod Electrode

Material: Copper-clad steel.

Diameter: 3/4- inch (19 mm) minimum.

Length: 10-feet (3.5 m) minimum. Rod shall be driven at least 9'-6" deep.

2. Mechanical Connectors

Mechanical connectors may only be used at specified locations, generally only above ground within the confined areas that do not allow use of exothermic connections. Refer to drawings details.

The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be

made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.

Split bolt connector types are NOT allowed.

The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

3. Compression Connectors

Compression connectors may only be used at specified locations above ground.

The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.

The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.

The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

Each connector shall be factory filled with an oxide-inhibiting compound.

4. Exothermic Connections

Generally shall be used to bond all components of the ground grid above and below ground.

Type: Powdered metal, dry mold type utilizing an exothermic reaction to produce molten copper to melt and weld connections together.

All materials used shall be the same type and by the same manufacturer.

5. Wire

Material: 6AWG stranded copper green insulated (aluminum not permitted), for interior grounding and between exterior cable tray (ice bridge) joints and support(s).

Grounding Electrode Conductor: 2AWG solid tinned copper wire for all exterior grounding as shown on drawings, specifications or as required by NFPA 70, whichever is larger.

Foundation Electrodes: As shown on drawings.

Manhole, Main Switchgear room and Vault Bonding: No. 4/0 minimum.

Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used on the same facility.

6. Bus

Material: Copper (aluminum not permitted). Copper bus bar(s) mounted on tower structure adjacent to tower base access ports. Bus bars mounted on tower provided and installed by the Contractor. Contractor shall bond bus bars to buried ground grid.

Contractor to furnish and install copper bus bar ¼-inch x 2-inch minimum.

PART 3 - EXECUTION

1. Examination

Verify that final backfill and compaction has been completed before driving rod electrodes.

2. General

Install products in accordance with manufacturer's instructions.

Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.

Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them. **Clean ground rods, wire brush at weld locations, make weld connection and paint area with cold galvanized paint at the completion of bonding process.**

Install rod electrodes at locations indicated or as required by Code, whichever requires the most rods. Install additional rod electrodes as required to achieve specified resistance to ground.

Install No. 2 AWG soled tinned copper wire ground ring around the tower support pier foundation perimeter. Provide bonding between this ground ring and radial extensions of the ground as shown on the drawings and where indicated. Refer to drawing details for more information. **Engineer will inspect all ground connections before placement of backfill over ground system.**

Provide bonding to meet Regulatory requirements.

Bond together existing interior ground leads and bus bar near cable entry to ground grid.

3. Less Than 600-Volt System Grounding

Supplementary Grounding Electrode: Use driven ground rod on exterior of building.

Bond together

4. Field Quality Control

Inspect grounding and bonding system conductors and connections for tightness and proper installation.

Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method. Resistance shall not exceed 2 ohms. Provide written results of resistance measurements to the engineer.

END OF SECTION 16170

C Measurement

The department will measure Communications Tower, completed in accordance to the contract and accepted, as a single complete unit of work.

D Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.09	Communications Tower	LS

Payment is full compensation for designing, furnishing all materials and all installation; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the contract work.

36. Electrical Service, SWEF Signs, Item SPV.0105.10.

A Description

The work includes disconnecting and reconnecting electrical service to the existing SWEF open/closed signs. The signs are located at the beginning of the SWEF ramp taper and at the ramp gore. The work includes all coordination and work as necessary to shut off current electrical service from the existing SWEF building and to provide electrical service from the new SWEF building, in accordance with the plans and as hereinafter provided.

B (Vacant)

C Construction

Disconnect existing electrical service from the existing SWEF building prior to demolition. Provide and install such new wiring and electrical service from the new SWEF building to each sign to make them operational.

D Measurement

The department will measure Electrical Service, SWEF Signs, completed in accordance to the contract and accepted, as a single complete unit of work.

E Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.10	Electrical Service, SWEF Signs	LS

Payment is full compensation for providing electric service from the new SWEF building; making all connections; wiring; installing and performing all associated coordination; and for furnishing all labor, material, equipment, tools, and incidentals necessary to complete the contract work.

37. General Requirements for Building Construction.

These general requirements are applicable to the following bid items for the SWEF building construction.

1. SWEF Building, General Construction
1. SWEF Building, Plumbing
2. SWEF Building, Heating and Ventilating
3. SWEF Building, Electrical

Work related to general requirements will not be paid separately, but shall be included in the applicable contract unit prices.

INDEX OF GENERAL REQUIREMENT SPECIFICATIONS

DIVISION 1 - GENERAL REQUIREMENTS

- 01010 - Summary of Work
- 01031 - Substitutions
- 01200 - Progress Documentation and Procedures
- 01300 - Submittals
- 01500 - Temporary Facilities and Services
- 01700 - Execution Requirements
- 01770 - Contract Closeout
- 01771 - Final Cleaning
- 01781 - Project Record Documents
- 01782 - Operating & Maintenance Data / Owner Training

1.1. Division 1 – General Requirements

1.1.1. Section 01010 – Summary of Work

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

- A. "General Building Contractor": The Work described in Divisions 1-16 are the responsibility of the General Building Contractor.
- B. "Roadway Contractor": The Work described in the "Roadway Special Provisions" are the responsibilities of the Roadway Contractor.
- C. "Roadway Special Provisions": Refers to the requirements for the roadway portion of the project, performed by the Roadway Contractor."
- D. "Standard Specifications": Refers to the State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Edition of 2003.
- E. "Building Specifications": Refers to the building specifications Divisions 1-16.
- F. "Scale Specifications" Refers to the static scale, weigh in motion, and virtual scale specifications.

1.3 PROJECT DESCRIPTION

- A. The BUILDING portion of the Project consists of
 - 1. A new Safety and Weight Enforcement Facility to be constructed near Madison, WI. The facility will include offices, toilet rooms, and storage areas.
- B. The BUILDING portion of the Work consists of:
 - 1. Construction will include a first floor area and underground access to a static scale. Work includes, but is not limited to concrete foundations, structural steel, engineered wood products, unit masonry, thermal and moisture protection, casework, millwork, aluminum curtain wall, standing seam metal roof system, metal studs and drywall, acoustic ceilings, painting, tile, carpeting, hollow metal doors and frames, wood doors, metal doors, finish hardware,. Also included is plumbing, HVAC, electrical, and communications cable and equipment.
- C. State Prevailing Wage Rates apply to the Work described in Divisions 1-16.

1.4 WORK SEQUENCE AND SCHEDULE

- A. The Work sequence for the Divisions 1 through 16 will be the General Building Contractor's responsibility to coordinate with the Owner, the Supervising Professional, and all required Trades.
- B. Refer to the Roadway Special Provisions for Substantial (Interim) and Final Building Completion dates.

1.5 PERMITS

- A. Local building permits shall be the responsibility of the General Building Contractor.

PART 2 - PRODUCTS (Not applicable).

PART 3 - EXECUTION (Not applicable).

END OF SECTION 01010

1.1.2. Section 01031 - Substitutions

PART 1 - GENERAL

1.1 SUMMARY

- A. This section refers to substitutions for the BUILDING portion of this contract only. Refer to "Submittals" in the Roadway Special Provisions for non-building substitutions.
- B. Substitutions: Substitutions may be used where 'approved equal' is specified. Substitutions must be approved by the Supervising Professional, and must meet or exceed specifications listed.
 - 1. The burden of proof that a substitution meets or exceeds the specifications shall be the responsibility of the proposer.
- C. For approval, the proposer must submit required data to the Supervising Professional in accordance with Section 01300, Submittals.
 - 1. Submit concise, annotated documentation comparing the specification to the proposed substitution.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01031

1.1.3. Section 01200 – Progress Documentation and Procedures

PART 1 - GENERAL

1.1 SUMMARY

- A. This section is covered in the sections entitled "Prosecution and Progress" in the Standard Specifications and in the Roadway Special Provisions.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

1.1.4. Section 01300 - Submittals

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Preparing and processing submittals for review and approval.
 - 2. Preparing and processing informational submittals.
- B. Related Sections: The following are specified elsewhere:
 - 1. Division 1 section for Operating and Maintenance Data.
 - 2. Division 1 section for Owner Training
 - 3. Division 1-16 sections for Warranties.
 - 4. Division 1-16 sections for Maintenance materials and tools.
- C. Submit the following for the Supervising Professional's review and approval:
 - 1. Shop drawings.
 - 2. Structural design information required by the contract documents.
 - 3. Manufacturer's standard printed product data.
 - 4. Submittals and other information required by Division 15 for mechanical Work.
 - 5. Submittals and other information required by Division 16 for electrical Work.
- D. Submit the following as informational submittals:
 - 1. Where applicable, submit to Supervising Professional manufacturer's standard printed product data of alternative selected.
- E. Do not commence work that requires review of any submittals until receipt of returned submittals with an acceptable action.
- F. All submittals are to be made to the Supervising Professional, unless otherwise instructed.
- G. Do not submit substitute items that have not been approved by the procedure specified in Section 1031 Substitutions.

1.3 DEFINITIONS

- A. "Shop drawings" are drawings and other data prepared, by the entity who is to do the work, specifically to show a portion of the work.
- B. "Product data submittals" are standard printed data which show or otherwise describe a product or system, or some other portion of the work.
 - 1. Product data submittals also include:
 - a. Selection data showing colors, and indicating color proposed.
 - b. Wiring diagrams, when standard for all products of that type.
- C. Informational Submittals: Submittals identified in the contract documents as to be submitted for information only.

1.4 NUMBER OF COPIES

- A. The General Building Contractor shall anticipate a minimum of 8 copies of blue or black-line prints, plus quantity required by the General Building Contractor. The final number of copies and their distribution shall be arranged at the Pre-Construction Meeting.
 - 1. General Building Contractor shall mark up and retain 2 returned copies for the Operations and Maintenance Manuals.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TIMING OF SUBMITTALS

- A. Transmit each submittal within 30 days of award of the contract.
- B. Deliver each submittal requiring approval in time to allow for a minimum of 20 working days for review and processing, not including resubmittals if necessary; failure of the General Building Contractor in this respect will not be considered as grounds for an extension of the contract time.
- C. If a submittal must be delayed for coordination with other submittals not yet submitted, the Supervising Professional may at his or her option either return the submittal with no action or notify the General Building Contractor of the other submittals which must be received before the submittal can be reviewed.

3.2 SUBMITTAL PROCEDURES - GENERAL

- A. Preparing Submittals:
 - 1. Label each copy of each submittal with the following information:
 - a. Project name.

- b. Date of submittal.
 - c. General Building Contractor's name and address.
 - d. Supplier's name and address.
 - e. Manufacturer's name.
 - f. Specification section number and title referencing the submittal is specified.
 - g. Numbers of applicable drawings and details.
 - h. Other necessary identifying information.
- B. Pack submittals suitably for shipment.
- C. Transmittal of Submittals:
General Building Contractor only. Submittals received from other entities will be returned without review or action.

3.3 SHOP DRAWINGS

- A. Content: Include the following information:
 - 1. Dimensions, at accurate scale.
 - 2. All field measurements that have been taken, at accurate scale.
 - 3. Names of specific products and materials used.
 - 4. Details, identified by contract document sheet and detail numbers.
 - 5. Show compliance with the specific standards referenced.
 - 6. Coordination requirements; show relationship to adjacent or critical work.
 - 7. Name of preparing firm.
- B. Preparation:
 - 1. Reproductions of contract documents are not acceptable as shop drawings.
 - 2. Electronic copies of the Contract Documents will not be provided by the Supervising Professional or Engineer.

3.4 PRODUCT DATA

- A. Submit all product data submittals for each system or unit of work as one submittal.
- B. When product data submittals are prepared specifically for this project (in the absence of standard printed information) submit such information as shop drawings-and not as product data submittals.
- C. Content:
 - 1. Submit manufacturer's standard printed data sheets.
 - 2. Identify the particular product being submitted;
 - 3. Submit only pertinent pages.
 - 4. Show compliance with properties specified.
 - 5. Identify which options and accessories are applicable.
 - 6. Show compliance with the specific standards referenced.

7. Indicate deviations from specifications.

3.5 REVIEW OF SUBMITTALS

- A. Submittals for approval will be reviewed, marked with appropriate action, and returned.
- B. Informational submittals: Submittals will be reviewed.
- C. Limitation on number of Supervising Professional's Review: Contractor is responsible for submitting complete, reviewed, and accurate information. The Supervising Professional will review up to two submittals without cost to the Contractor. The Supervising Professional's time beyond two reviews may be deducted from the Contractor's balance.

3.6 RETURN, RESUBMITTAL, AND DISTRIBUTION

- A. Submittals will be returned to the contractor by mail or in person to authorized contractor personnel on the jobsite.
- B. Perform resubmittals in the same manner as original submittals; indicate all changes by "clouding" the particular items revised, (both those requested, and not requested, by the Supervising Professional).
- C. Distribution: Provide extra copies for operation and maintenance data submittals as indicated in paragraph 1.4 of this section.

END OF SECTION 01300

1.1.5. Section 01500 – Temporary Facilities and Services

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Refer to Divisions 15 and 16 for temporary building facilities and services such as heat and lighting.
- B. Temporary site facilities and services are provided by the roadway contractor, and are covered elsewhere in the Standard Specifications and in these Roadway Special Provisions.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01500

1.1.6. Section 01700 – Execution Requirements

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. General installation of products.
 - 4. Coordination of Owner-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.
- B. Related Sections include the following:
 - 1. Standard Specifications "Prosecution and Progress" for procedures for coordinating field engineering with other construction activities.

1.3 SUBMITTALS

- A. Qualification Data: For land surveyor to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Supervising Professionals and owners, and other information specified.
- B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- D. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.4 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of storm sewer and water-service piping; and underground electrical services.
 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Supervising Professional not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Supervising Professional's written permission.
- C. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- D. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- E. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Supervising Professional. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Supervising Professional promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 3. Inform installers of lines and levels to which they must comply.

4. Check the location, level and plumb, of every major element as the Work progresses.
 5. Notify Supervising Professional when deviations from required lines and levels exceed allowable tolerances.
 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations (refer to structural plans for detail denoting control between site and foundation).
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Supervising Professional.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Supervising Professional. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Supervising Professional before proceeding.
 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.

3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 4. Maintain minimum headroom clearance of 8 feet (2.4 m) in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Supervising Professional.
 2. Allow for building movement, including thermal expansion and contraction.
- G. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction forces.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.
 - 1. Construction Schedule: Inform Owner of General Building Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 - 2. Pre-installation Conferences: Include Owner's construction forces at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-installation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris. temperature is expected to rise above 80 deg F (27 deg C).
 - 2. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
 - 1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
- H. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- K. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 1 Section "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01700

1.1.7. Section 01770 – Project Closeout

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for project closeout, including:
 - 1. Substantial Completion.
 - 2. Final Completion and Final Payment.
- B. Closeout requirements for specific construction activities are included in the appropriate Sections in Divisions 2 through 16.
- C. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 01300 “Submittals”.
 - 2. Section 01771 “Final Cleaning”.
 - 3. Section 01781 “Project Record Documents”.
 - 4. Section 01782 “Operating and Maintenance Data/Owner Training”.

1.3 SUBSTANTIAL COMPLETION

- A. General: Before requesting inspection for certification of Substantial Completion, complete checklists A, B, and C, which are found in this manual. Return the signed forms to the Supervising Professional. Inspection for Substantial Completion will not be conducted until the Supervising Professional is satisfied that these requirements have been met.
- B. Application for Payment: In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
 - 1. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.

- C. Inspection Procedures: Upon receiving the request for inspection, the Supervising Professional will either proceed with inspection or advise the General Building Contractor of unfilled requirements. The Supervising Professional will prepare the Certificate of Substantial Completion following inspection, or advise the General Building Contractor of construction that must be completed or corrected before the certificate will be issued.
1. The Supervising Professional will repeat inspection when requested and assure that the Work has been substantially completed. The General Building Contractor shall be responsible for hourly payments of additional site reviews made by the Supervising Professional or Engineer with costs deducted from the General Building Contractor's balance.
 2. Results of the completed inspection will form the basis of requirements for final acceptance.

SUBSTANTIAL COMPLETION – CHECKLIST A

General Building Contractor Responsibilities

Prior to the General Building Contractor's request for Substantial Completion, the General Building Contractor is responsible for the following:

- ☐ Submit a list to the Supervising Professional of incomplete items, stating reasons why each of the items is incomplete. The General Building Contractor shall stipulate a monetary value to complete each item.
- ☐ Notify the Owner 30 days prior to any insurance coverage changes. Copy the Supervising Professional on this correspondence.
- ☐ Submit all warranties, maintenance contracts, and required operating instructions to the Supervising Professional for review and distribution to the Owner. See section 1782 for timing.
- ☐ Obtain the Certificate of Occupancy to allow the Owner's full and unrestricted use of the project. General Building Contractor to check with the local zoning ordinance for required permits or certificates. Submit to the Supervising Professional for review and distribution to the Owner.
- ☐ Submit record documents that show all changes made during construction, including all drawings, specifications, and addenda. Submit to the Supervising Professional for distribution to the Owner.
- ☐ Deliver to the Owner material replacement and maintenance stock as called for in the specifications.
- ☐ Complete the keying schedule, and deliver to the Owner with properly tagged master, submaster, room and special keys. Make final changes to lock cylinders and coordinate shifting building security to the Owner.
- ☐ Instruct the owner to operate and maintain all systems and equipment. Submit completed copies of checklist C from Section 1782 to the Supervising Professional.
- ☐ Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- ☐ Complete the final clean up requirements, including touch up painting. Restore all damaged finishes. Submit completed checklist B to the Supervising Professional. See Section 01771.
- ☐ Submit all required guarantees, certificates of inspections, and bonds. Sign a written guarantee at the completion of the work that covers all items requiring guarantees under the specifications. Submit copies to the Owner and Supervising Professional.

To the best of my knowledge, the above list has been completed. I hereby request the Supervising Professional's inspection for substantial completion.

General Building Contractor's Signature	Representing	Date
Return this completed, signed form to the Supervising Professional		

1.4 FINAL ACCEPTANCE

- A. General: Before requesting final inspection for certification of final completion and final payment, comply with the following checklist. List exceptions in the request.
- B. FINAL COMPLETION
 - 1. General Building Contractor's Responsibilities:
 - a. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
 - b. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
 - c. Submit a certified copy of the Supervising Professional's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by the Supervising Professional.
 - d. Submit consent of surety to final payment.
 - e. Submit a final liquidated damages settlement statement.
 - f. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. Reinspection Procedure: The Supervising Professional will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to the Supervising Professional.
 - 1. Upon completion of reinspection, the Supervising Professional will prepare a certificate of final completion, or advise the General Building Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance. The General Building Contractor shall be responsible for hourly payments of additional site reviews made by the Supervising Professional or Engineer with costs deducted from General Building Contractor balance.

PART 2 (Not Applicable)

PART 3 (Not Applicable)

END OF SECTION 01770

1.1.8. Section 01771 – Final Cleaning

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for final cleaning at Substantial Completion.
 - 1. Special cleaning requirements for specific elements of the Work are included in appropriate Sections of the specifications.
- B. General cleanup and waste removal requirements are included elsewhere in the Standard Specifications.
- C. Except as otherwise indicated, each General Building Contractor is responsible for final cleaning their own work. The General Building Contractor is responsible for coordination of final cleaning where more than one prime Contractor is involved in final cleaning a single area or piece of equipment.
- D. Environmental Requirements: Conduct cleaning and waste disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and anti-pollution regulations.
 - 1. Do not dispose of volatile wastes such as mineral spirits, oil or paint thinner in storm or sanitary drains.
 - 2. Do not burn or bury debris, rubbish or other waste material on the premises.

PART 2 - PRODUCTS: (Not Applicable)

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning operations when indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to the condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

- B. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion for the entire Project or a portion of the Project. Complete checklist B, sign form, and submit to Supervising Professional.
- C. Compliance: Remove waste materials from the site and dispose of in a lawful manner.
 - 1. Where extra materials of value remain after completion of associated construction have become the Owner's property, dispose of these materials as directed.
- D. Removing Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.

FINAL CLEANING - CHECKLIST B

- ☐ Clean the Project site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste materials, litter and foreign substances. Sweep paved areas broom clean. Remove petro-chemical spills, stains and other foreign deposits. Rake grounds that are neither planted nor paved, to a smooth even-textured surface.
- ☐ Remove tools, construction equipment, machinery and surplus material from the site.
- ☐ Remove snow and ice to provide safe access to the building.
- ☐ Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
- ☐ Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics and similar spaces.
- ☐ Wash concrete floors in unoccupied spaces.
- ☐ Vacuum clean carpet and similar soft surfaces, removing debris and excess nap. Shampoo if required.
- ☐ Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
- ☐ Remove labels that are not permanent labels.
- ☐ Touch-up and otherwise repair and restore marred exposed finishes and surfaces. Replace finishes and surfaces that can not be satisfactorily repaired or restored, or that show evidence of repair or restoration. Do not paint over "UL" and similar labels, including mechanical and electrical name plates.
- ☐ Wipe interior surfaces of all cabinetwork including shelves, vertical dividers, and drawers.
- ☐ Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings and other foreign substances.
- ☐ Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
- ☐ Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills. Clean ducts, blowers, and coils if units were operated for temporary facilities during construction.
- ☐ Clean light fixtures, lamps, globes and reflectors to function with full efficiency. Replace burned out bulbs, and defective and noisy starters in fluorescent and mercury vapor fixtures.
- ☐ Leave the Project clean and ready for occupancy.

To the best of my knowledge, the above list has been completed.

General Building Contractor Signature

Representing

Date

Return this completed, signed form to the Supervising Professional prior to requesting inspection for Substantial Completion.

END OF SECTION 01771

1.1.9. Section 01781 – Project Record Documents

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents. Project Record Documents required include the following:
 - 1. Marked-up copies of Contract Drawings.
 - 2. Marked-up copies of Specifications and addenda.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 01300 “Submittals”.
 - 2. Section 01770 “Project Closeout”.
 - 3. Divisions 2 through 16 Sections for specifying Project Record Document requirements for specific pieces of equipment or building operating systems.
- C. Maintaining Documents and Samples: Store record documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition. Make documents available at all times for the Supervising Professional's inspections.

1.3 RECORD DRAWINGS

- A. Markup Procedure: During construction, maintain a set of blue- or black-line white prints of Contract Drawings and Shop Drawings for Project Record Document purposes.
 - 1. Mark these Drawings to show the actual installation where the installation varies from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:
 - a. Dimensional changes to the Drawings.
 - b. Revisions to details shown on the Drawings.
 - c. Depths of foundations below the first floor.
 - d. Location and depth of underground utilities.

- e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by change order or Construction Change Directive.
 - k. Changes made following the Supervising Professional's written orders.
 - l. Details not on original Contract Drawings.
- 2. Mark record sets with red erasable colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 - 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - 4. Note Construction Change Directive numbers, alternate numbers, change-order numbers, supplemental instructions number, construction bulletin numbers, and similar identification.
- B. Responsibility for Markup: The General Building Contractor, whether the individual or entity is the installer, subcontractor, or similar entity, shall prepare the markup on record drawings.
- 1. Accurately record information in an understandable drawing technique.
 - 2. Record data as soon as possible after obtaining it. Record and check the markup prior to enclosing concealed installations.
 - 3. At time of Substantial Completion, submit record drawings to the Supervising Professional for the Owner's records. Organize into sets and bind with durable cover sheets that include appropriate identification, including titles, dates, and other information.

1.4 RECORD SPECIFICATIONS

- A. During the construction period, maintain 1 copy of the Project Specifications, including addenda and modifications issued, for Project Record Document purposes.
- 1. Mark the Specifications to indicate information on concealed installations that would be difficult to identify or measure and record later.
 - 2. Upon completion of markup, submit record Specifications to the Supervising Professional for the Owner's records.
 - 3. Each prime contractor is responsible for marking up Sections that contain its own Work.
 - a. The General Building Contractor is responsible for collecting marked-up record Sections from each of the other prime contractors. The General Building Contractor is also responsible for collating these Sections in proper numeric order with its own Sections to form a complete set of record Specifications.
 - b. The General Building Contractor is responsible for submitting the complete set of record Specifications as specified.

1.5 MISCELLANEOUS RECORD SUBMITTALS

- A. Refer to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Immediately prior to Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Submit to the Supervising Professional for the Owner's records.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 RECORDING

- A. Post changes and modifications to the Documents as they occur. Do not wait until the end of the Project.

END OF SECTION 01781

1.1.10. Section 01782 – Operating & Maintenance Data/ Owner Training

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for operating and maintenance manuals including the following:
 - 1. Operating and maintenance manuals.
 - 2. Material finish and maintenance information.
 - 3. Owner training and instruction.
- B. Related Sections:
 - 1. Division 2-16 Sections for special operating and maintenance data requirements for specific pieces of equipment or building operating systems.
 - 2. Section 01300 “Submittals” for preparing shop drawings and product data.
 - 3. Section 01770 “Project Close out” for general closeout requirements.

1.3 SUBMITTALS

- A. Initial Submittal: Submit 1 draft copy of each manual at least 21 days before requesting inspection for Substantial Completion. Refer to SUBSTANTIAL COMPLETION Checklist A, Section 01770. Include a complete operation and maintenance directory. Supervising Professional will return 1 copy of draft and mark whether general scope and content of manual are acceptable.
- B. Final Submittal: Submit 1 copy of each manual in final form at least 15 days before final inspection. Supervising Professional will return copy with comments within 15 days after final inspection.
 - 1. Correct or modify each manual to comply with Supervising Professional's comments. Submit 3 copies of each corrected manual within 15 days of receipt of Supervising Professional's comments.

PART TWO – PRODUCTS

2.1 MANUALS, GENERAL

- A. Organization: Organize manuals into suitable sets of manageable size.

- B. Identification: Bind data into individual binders for each manual, properly identified on front and spine. For large manuals, provide an index sheet and thumb tabs for separate categories.
- C. Binders: Provide heavy-duty, 3-ring, vinyl-covered binders, 1 to 2 inch (25 to 50 mm) thick as required to contain information, sized for 8-1/2-by-11-inch (215-by-280-mm) paper with inside pockets or pocket folders for folded sheets.
- D. Table of Contents: After the Title Page, include a typewritten table of contents for each volume, arranged systematically according to the Project Manual format. Include a list of each product included, identified by product name or other appropriate identifying symbol and indexed to the content of the volume.
- E. Content: In each manual, include information specified in individual Specification Sections and in this Section.
- F. Warranties, Bonds and Service Contracts: Provide a copy of each warranty, bond or service contract in the appropriate manual for the information of the Owner's operating personnel.
- G. Provide written data outlining procedures to be followed in the event of product failure. List circumstances and conditions that would affect validity of the warranty or bond.
- H. Responsibility: The General Contractor is responsible for submitting maintenance manuals for all Work. Where a manual includes information on installations by more than one contract, the Contractor who is the principal source of information shall receive information from other contractors, coordinate and collate information for a unified manual, and provide binders and submittal as specified.

2.2 OPERATION MANUALS

- A. For each major building component and its controls, include the following in the manuals for daily operations and management of the systems and equipment:
 - 1. System or equipment description with design factors and assumptions.
 - 2. Manufacturer Name.
 - 3. Model number.
 - 4. Serial number of each component.
 - 5. Emergency instructions.
 - 6. Spare parts list.
 - 7. Copies of specific warranties, bonds, and service contracts.
 - 8. Wiring diagrams.
 - 9. Recommended maintenance procedures and turn-around times.
 - 10. Inspection and system-test procedures.

11. Copies of applicable Shop Drawings and Product Data.
12. Listing of required maintenance materials.
13. Names and addresses of sources of maintenance materials.
14. Maintenance drawings and diagrams.
15. Precautions against improper maintenance and exposure.

2.3 MATERIAL AND PRODUCT MAINTENANCE MANUALS

- A. Architectural Products: Provide manufacturer's data and instructions on care and maintenance of architectural products, including applied materials and finishes, as applicable:
 1. Manufacturer's catalog number.
 2. Size.
 3. Material composition.
 4. Color.
 5. Texture.
 6. Reordering information for specially manufactured products.
- B. Care and Maintenance Instructions: Provide information on care and maintenance, including manufacturer's recommendations for types of cleaning agents to be used and methods of cleaning. Provide information regarding cleaning agents and methods that could prove detrimental to the product. Include manufacturer's recommended schedule for cleaning and maintenance.
- C. Moisture-Protection and Weather-Exposed Products: Provide complete manufacturer's data with instructions on inspection, maintenance and repair of products exposed to the weather or designed for moisture-protection purposes, as applicable:
 1. Applicable standards.
 2. Chemical composition.
 3. Installation details.
 4. Inspection procedures.
 5. Maintenance information.
 6. Repair procedures.

2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Equipment and Systems: Provide the following information for each piece of equipment, each building operating system, and each electric or electronic system.
 1. Description: Provide a complete description of each unit and related component parts, including the following:
 - a. Equipment or system function.
 - b. Operating characteristics.
 - c. Limiting conditions.
 - d. Performance curves.
 - e. Engineering data and tests.

- f. Complete nomenclature and number of replacement parts.
- 2. Manufacturer's Information: For each manufacturer of a component part or piece of equipment provide the following:
 - a. Printed operating and maintenance instructions.
 - b. Assembly drawings and diagrams required for maintenance.
 - c. List of items recommended to be stocked as spare parts.
- 3. Maintenance Procedures: Provide information detailing essential maintenance procedures, including the following:
 - a. Routine operations.
 - b. Trouble-shooting guide.
 - c. Disassembly, repair and reassembly
 - d. Alignment, adjusting and checking.
- 4. Operating Procedures: Provide information on equipment and system operating procedures, including the following:
 - a. Start-up procedures.
 - b. Equipment or system break-in.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Instructions on stopping.
 - f. Shut-down and emergency instructions.
 - g. Summer and winter operating instructions.
 - h. Required sequences for electric or electronic systems.
 - i. Special operating instructions.
- 5. Servicing Schedule: Provide a schedule of routine servicing and lubrication requirements, including a list of required lubricants for equipment with moving parts.
- 6. Controls: Provide a description of the sequence of operation and as-installed control diagrams by the control manufacturer for systems requiring controls.
 - a. Provide as-installed color-coded piping diagrams, where required for identification.
- 7. Valve Tags: Provide charts of valve tag numbers, with the location and function of each valve.
- 8. Circuit Directories: For electric and electronic systems, provide complete circuit directories of panel boards, including the following:
 - a. Electric service.
 - b. Controls.
 - c. Communication.

PART THREE - EXECUTION

3.1 INSTRUCTING THE OWNER'S AND/OR TENANT'S PERSONNEL

- A. General: Prior to final inspection, instruct the Owner's and/or Tenant's personnel in operation, adjustment, and maintenance of products, equipment and systems. Provide instruction at mutually agreed upon times.

- B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
1. Fire-protection systems.
 2. Motorized doors.
 3. Intrusion detection systems.
 4. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
 5. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
 6. HVAC instrumentation and controls.
 7. Electrical service and distribution, including transformers, switchboards, panelboards, uninterruptible power supplies, and motor controls.
 8. Packaged engine generators, including transfer switches.
 9. Lighting equipment and controls.
 10. Communication systems, including surveillance, and television equipment.
- C. For equipment that requires seasonal operation, provide similar instruction during other seasons.
- D. Use the operation and maintenance manuals for each piece of equipment or system as the basis of instruction. Review contents in detail to explain all aspects of operation and maintenance.
- E. Complete Checklist C for each system requiring instruction or training, and submit to the Supervising Professional prior to requesting inspection for Substantial Completion.

**CHECKLIST C - OPERATING AND MAINTENANCE INSTRUCTIONS
OWNER TRAINING & DEMONSTRATION CERTIFICATION**

Project Name: _____

Project No._____

Building Component/System

Training conducted by (Name, Company)

The General Building Contractor shall arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:

- ☐ Maintenance manuals.
 - ☐ Record documents.
 - ☐ Spare parts and materials.
 - ☐ Tools.
 - ☐ Lubricants.
 - ☐ Fuels.
 - ☐ Identification systems.
 - ☐ Control sequences.
 - ☐ Hazards.
 - ☐ Cleaning.
 - ☐ Warranties and bonds.
 - ☐ Maintenance agreements and similar continuing commitments.
- ☐ As part of instruction for operating equipment, demonstrate the following procedures:
- ☐ Start-up.
 - ☐ Shutdown.
 - ☐ Emergency operations.
 - ☐ Noise and vibration adjustments.
 - ☐ Safety procedures.
 - ☐ Economy and efficiency adjustments.
 - ☐ Effective energy utilization.

I have completed the above review to the Owner's satisfaction.

Owner Signature

Representing

Date

General Building Contractor Signature

Representing

Date

Return this completed, signed form to the Supervising Professional prior to requesting Final Inspection. (Use as many forms as required by Specification Divisions 1 -16.)

END OF SECTION 01782

38. SWEF Building, General Construction, SPV.0105.11.

A Description

This item consists of the general construction work for the SWEF (Safety & Weight Enforcement Facility) building. The work shall be in accordance with the applicable plans and the following specifications.

B Measurement

The department will measure SWEF Building, General Construction, completed in accordance with the contract and accepted, as a single complete unit of work.

C Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.11	SWEF Building, General Construction	LS

Payment shall be full compensation for furnishing all materials and equipment; and for supplying all labor, tools, equipment, and incidentals necessary to complete the work.

1.1. Division 1 – General Requirements

See previous article, General Requirements For Building Construction.

1.2. Division 2 – Sitework

1.2.1. Section 02300 – Earthwork

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.
- B. Soils Report: Soils report is available from the Supervising Professional and should be reviewed by the General Building Contractor before commencing work.

1.2 SCOPE

- A. This section covers foundation requirements for the subject building only. This section covers all soil inside a volume bounded by the outside perimeter footings down to bottom of footing level, at which the volume expands outwards at a 1 foot downward for each 1 foot outward slope to down to satisfactory native soils. Payment for the above defined earthwork is covered by this section alone.

Payment and requirements for the remainder of the site earthwork is not covered by this section, but by other section(s) within the project specification.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Preparing subgrades for slabs-on-grade.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Drainage course for slabs-on-grade.
 - 4. Dewatering.
 - 5. Subsurface drainage backfill for walls and trenches (If necessary).
 - 6. Excavating and backfilling trenches within building lines.
 - 7. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.
- B. Related Sections include the following:
 - 1. Division 1 Section "Construction Facilities and Temporary Controls."
 - 2. Division 3 Section "Cast-in-Place Concrete" for fine-graded granular material under vapor retarder.
 - 3. Division 7 Section "Self-Adhering, Sheet Waterproofing."
 - 4. Division 15 and 16 Sections for excavating and backfilling buried mechanical and electrical utilities and buried utility structures.
- C. If rock is encountered, refer to the Standard Specifications for procedures.

1.4 DEFINITIONS

- A. Backfill: Soil materials 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. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.
- C. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- D. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- E. Excavation: Removal of material encountered above subgrade elevations.
 - 1. Additional Excavation: Excavation below subgrade elevations as directed by Supervising Professional. Additional excavation and replacement material will be paid for as Common Excavation per approval by Supervising Professional.

2. Bulk Excavation: Excavations more than 10 feet (3 m) in width and pits more than 30 feet (9 m) in either length or width.
 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Supervising Professional. Unauthorized excavation, as well as remedial work directed by Supervising Professional, shall be without additional compensation.
- F. Fill: Soil materials used to raise existing grades.
- G. 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.
- H. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- I. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- J. Proof-rolling: Loading the native soil using a fully loaded, triaxle dump truck or other heavy construction equipment to detect soft or unstable soils, which will rut, yield, or pump under load.

1.5 SUBMITTALS

- A. Samples: Samples, of an adequate size and sealed in airtight containers, of each proposed soil material from on-site or borrow sources shall be submitted to the supervising professional for testing prior to performance of the work of this section.
- B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
 2. Laboratory compaction curve according to ASTM D 1557 for each on-site or borrow soil material proposed for fill and backfill.

1.6 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548, and acceptable to the Wisconsin Department of Transportation.

1.7 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Supervising Professional and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Supervising Professional not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Supervising Professional's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active. Coordinate this work with building demolition contractor.

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:
 - 1. ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
 - 2. ASTM D2487 soil classification groups GC, SC, CL, or ML may be allowed to remain in place IF:
 - a. The soils are determined to be native to the position encountered and remain in their natural, undisturbed state
 - AND
 - b. The soils, as encountered, are determined to be capable of supporting the design loads imposed by the proposed structures.
 - 3. Under no circumstances shall the soils described in paragraph 2 be used for fill or as borrow.
- C. Unsatisfactory Soils: ASTM D 2487 soil classification groups MH, CH, OL, OH, and PT, or a combination of these group symbols. ASTM D2487 soil classification groups GC, SC, ML, and CL, or a combination of these group symbols shall not be used as fill.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

- D. Compacted Granular Base: Drainage Course under vapor barrier below slabs-on-grade, 6 inches minimum.
- E. Backfill and Fill: Satisfactory soil materials.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with 100 percent passing a 1-inch (25-mm) sieve and not more than 10 percent passing a No. 200 (0.075-mm) sieve. Soils report states the recommended fill gradation in Table 2 of the report.
- G. Bedding: 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 (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- H. Drainage Course: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (38-mm) sieve, 35 percent passing a 1-inch (25-mm) sieve, and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.
- J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.
- K. Geotextile: Artificial fabric used as a separation-type interface between proof-rolled native soil and subgrade fill.

2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. 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 earthwork operations.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide 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.
- D. Provide erosion control during the entire project as specified in Standard Specifications and elsewhere in the building specifications.

3.2 PROTECTION OF EXCAVATION

- 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.
 - 2. The installation of a dewatering system to keep subgrades dry and convey ground water away from excavations may be required during heavy rains. Maintain until dewatering is no longer required. Dewatering shall be considered incidental to the work of this section.
 - a. Areas to receive bentonite and membranes shall be dewatered to ensure surfaces are sufficiently dry for application of the waterproofing system.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

- A. Classified Excavation: Excavation to subgrade elevations classified as earth and rock. Rock excavation will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents for Common 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; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections. As directed by the Supervising Professional, excavations may be extended below indicated elevation under structures down to acceptable native soils, removing all undocumented fill and soil containing more than 5% organics, and replacing with compacted Engineered Fill.
 1. Excavations for Footings, Foundations, and Scale Tunnel: 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. Excavations for Slab-on-Grade: Excavate 2 feet below finished floor slab and replace with Engineered Fill below compacted Granular Base.
 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 (25 mm). Do not disturb the bottom of excavations that are intended to be the bearing surface.

3.6 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 a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 1. For pipes and conduit less than 6 inches (150 mm) in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.

3. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 APPROVAL OF SUBGRADE

- A. Notify Supervising Professional when excavations have reached required subgrade.
- B. If Supervising Professional determines that unsatisfactory soil is present, continue excavation to a depth determined by the Supervising Professional and replace with compacted backfill or fill material as directed.
 1. Additional excavation and replacement material will be paid as Common Excavation per approval by Supervising Professional.
- C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Supervising Professional.

3.8 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 may be used when approved by Supervising Professional.
 1. Fill unauthorized excavations under other construction or utility pipe as directed by Supervising Professional.

3.9 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile 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.

3.10 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 - a. Backfill shall be placed and compacted immediately upon completion of installation of positive-side waterproofing and associated materials.

2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing 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.

3.11 UTILITY TRENCH BACKFILL

- A. 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.
- B. Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings; fill with concrete to elevation of bottom of footings.
- C. Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.
 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
- D. Coordinate backfilling with utilities testing.
- E. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.
- F. Place and compact final backfill of satisfactory soil material to final subgrade.
- G. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.12 FILL

- A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
- B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- C. Place and compact fill material in layers to required elevations as follows:
 1. Under steps and ramps, use engineered fill.
 2. Under building slabs, use engineered fill.
 3. Under footings and foundations, use engineered fill to a minimum depth of 18 inches below all footings.

3.13 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill 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.

3.14 COMPACTION OF BACKFILLS AND FILLS

- A. Place backfill and fill materials in layers not more than 12 inches (300 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 8 inches (200 mm) in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
 - 1. Under structures, building slabs and steps, compact each layer of backfill, engineered fill, granular base, or fill material at 95 percent.

3.15 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from 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. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.16 DRAINAGE COURSE

- A. Under slabs-on-grade, place drainage course on prepared subgrade and as follows:
 - 1. Compact drainage course to required cross sections and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

2. When compacted thickness of drainage course is 6 inches (150 mm) or less, place materials in a single layer.
3. When compacted thickness of drainage course exceeds 6 inches (150 mm), place materials in equal layers, with no layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick when compacted.

3.17 DRAINTILE

- A. Install drainage pipe along the outside footing edge of the outside perimeter of the building and the scale tunnel. Refer to the structural and plumbing plans for size, location, and details.

3.18 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency that may be either part of, affiliated with, or independent of the owner, to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. 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 Supervising Professional.
- D. 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. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of building slab, but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet (30 m) 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 each 150 feet (46 m) or less of trench length, but no fewer than two tests.
- E. 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 to depth required; recompact and retest until specified compaction is obtained, at no cost to owner.

3.19 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 Supervising Professional; reshape and recompact.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

3.21 NOTIFICATION OF EXISTING CONDITIONS

- A. The General Building Contractor will, upon becoming aware of subsurface or latent physical conditions differing from those disclosed by the original soil investigation work, promptly notify the Supervising Professional verbally to permit verification of the conditions, and in writing, as to the nature of the differing conditions. No claim by the General Building Contractor for any conditions differing from those anticipated in the plans and specifications and disclosed by the soil studies will be allowed unless the General Building Contractor has so notified the Supervising Professional, verbally and in writing, as required above, of such differing conditions.

END OF SECTION 02300

1.3. Division 3 – Concrete

1.3.1. Section 03300 – Cast-in-Place Concrete

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 specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for drainage fill under slabs-on-grade.
 - 2. Division 7 Section "Self-Adhering Sheet Waterproofing".
 - 3. Division 16 Sections for in-slab and under-slab conduits and electrical equipment.

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, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mix water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- D. Welding Certificates: Copies of certificates for welding procedures and personnel.

- E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials.
- F. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 - 1. Cementitious materials and aggregates.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Admixtures.
 - 4. Vapor retarders.
 - 5. Curing materials.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- C. 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.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- F. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
 - 1. ACI 301, "Specification for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
 - 1. Avoid damaging coatings on steel reinforcement.

2. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Furnish formwork and form accessories according to ACI 301.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M.
- C. Steel Bar Mats: ASTM A 184/A 184M, assembled with clips.
 1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60, deformed bars.
 2. Steel Reinforcement: ASTM A 706/A 706M, deformed bars.
- D. Plain-Steel Wire: ASTM A 82, as drawn.
- E. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- F. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

2.3 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- C. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

- D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 755M.

2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Types I or II, or Type I/II.
- B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, not exceeding 3/4-inch nominal size.
- C. Water: Potable and complying with ASTM C 94.

2.5 ADMIXTURES

- A. General: Admixtures 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.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.6 VAPOR RETARDERS

- A. Vapor Retarder: ASTM E 1745, Class C, of one of the following materials; or polyethylene sheet, ASTM D 4397, not less than 10 mils thick:
 - 1. Nonwoven, polyester-reinforced, polyethylene coated sheet; 10 mils thick.
 - 2. Three-ply, nylon- or polyester-cord-reinforced, laminated, high-density polyethylene sheet; 7.8 mils thick.
- B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; meeting deleterious substance limits of ASTM C 33 for fine aggregates.
- C. Compacted Granular Base: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve, 35 percent passing a 1-inch sieve, and 0 to 5 percent passing a No. 8 sieve.

2.7 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Available Products:
 - a. Dayton Superior Corporation; Sure Film.
 - b. W.R. Meadows, Inc; Sealtight Evapre.
 - c. MBT Protection and Repair, Division of ChemRex; Confilm.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Available Products:
 - a. Dayton Superior Corp.; Day Chem Rez Cure (J-11-W).
 - b. W.R. Meadows, Inc; 1100 Clear.
 - c. Tamms Industries, Inc. Horncure WB 30.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound (SEAL): ASTM C309, ASTM C 1315, Type 1, Class A.
 - 1. Available Products:
 - a. Dayton Superior Corp; SAFE CURE & SEAL 30% (J-19).
 - b. W.R. Meadows, Inc; VOCOMP-30.
 - c. Euclid Chemical Company; SUPER REZ-SEAL.

2.12 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.
- B. Epoxy Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.13 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test databases, as follows:

1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:
 1. Compressive Strength (28 Days): 4000 psi.
 2. Maximum Slump: 4 inches.
 3. Maximum Slump for Concrete Containing High-Range Water-Reducing Admixture: 8 inches after admixture is added to concrete with 2- to 4-inch slump.
 4. Water Cement Ratio: 0.45 (non-air entrained)
- D. Slab-on-Grade: Proportion normal-weight concrete mix as follows:
 1. Compressive Strength (28 Days): 4000 psi.
 2. Water Cement Ratio: 0.45 maximum (non-air entrained), 0.35 maximum (air entrained).
 3. Maximum Slump: 4 inches.
- E. Exterior Walks, Stairs, Scale Tunnel:
 1. Compressive Strength (28 Days): 4000 psi.
 2. Water Cement Ratio: 0.45 maximum (non-air entrained), 0.40 maximum (air entrained).
 3. Maximum Slump: 4 inches.
- F. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated:
 1. Air Content: 6 percent for 3/4-inch nominal maximum aggregate size.
- G. Do not air entrain concrete to trowel-finished interior floors. Do not allow entrapped air content to exceed 3 percent.
- H. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- I. Limit use of fly ash not to exceed 20 percent of cement content by weight.
- J. Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) 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.
 3. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air entraining admixture at manufacturer's

prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or-minus 1-1/2 percent within the following limits:

- a. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or subject to hydraulic pressure:
 - 1) 5 percent (moderate exposure); 6 percent (severe exposure) 3/4" maximum aggregate.

2.14 FABRICATING REINFORCEMENT

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

2.15 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor bolts, accurately located, to elevations required.
 - 2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 3. Install dovetail anchor slots in concrete structures as indicated.

3.3 VAPOR RETARDERS

- A. General: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.

- B. Placement: Place sheets in position with lowest dimensions parallel with direction of pour. Lap joint 6 inches (150 mm) minimum and seal with manufacturer's recommended tape.
- C. Fine-Graded Granular Material: Install vapor retarder on top of 4-inch minimum fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch. See plan for details.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Supervising Professional.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Supervising Professional.

- C. 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. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 - 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.
- E. 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.
- F. 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.
- G. 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. 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 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. Apply to concrete surfaces not exposed to view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to view.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete exposed to view:
1. Smooth Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.
 - 1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
 - 2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15.
 - 3. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 10-foot-long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
 - a. 1/4 inch.
- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Supervising Professional before application.

3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.10 TOLERANCES

- A. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".

3.11 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. 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 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. 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 floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
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.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power sprayer 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 to achieve a uniform, high gloss finish.

3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semi-rigid epoxy joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Supervising Professional. Remove and replace concrete that cannot be repaired and patched to Supervising Professional's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. 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.
- D. Perform structural repairs of concrete, subject to Supervising Professional's approval, using epoxy adhesive and patching mortar.
- E. Repair materials and installation not specified above may be used, subject to Supervising Professional's approval.

3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.
- 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 one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - 2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 3. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 - 4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 6. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
 - a. Cast and field cure one set of four standard cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
 - a. Test two field-cured specimens at 7 days and two at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Strength of each concrete mix will be satisfactory if every 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.
- E. 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 mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Supervising Professional but will not be used as sole basis for approval or rejection of concrete.
- G. 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 Supervising Professional. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Supervising Professional.

END OF SECTION 03300

Division 4 – Masonry

1.3.2. Section 04810 – Unit Masonry Assemblies

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Concrete unit masonry assemblies.
 - 2. Reinforced unit masonry assemblies.
 - 3. Insulation in masonry walls.
 - 4. Flashing in masonry walls.
- B. Products installed but not furnished under this Section include the following:
 - 1. Steel lintels for unit masonry specified in Division 5 Section "Structural Steel."
 - 2. Wood nailers and blocking built into unit masonry specified in Division 6 Section "Miscellaneous Carpentry."
 - 3. Hollow metal frames in unit masonry openings specified in Division 8 Section "Steel Doors and Frames."
 - 4. Aluminum frames in unit masonry openings specified in Division 8 Section "Aluminum Frames."
 - 5. Division 10 for recessed and semi-recessed accessories built into unit masonry.
 - 6. Division 15 for plumbing fixtures built into unit masonry.
 - 7. Division 16 for electrical items built into unit masonry.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops the following installed compressive strengths (f'm) at 28 days.
 - 1. For Concrete Unit Masonry: As follows, based on net area:
 - a. f'm = 2,000 psi.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

- B. Product Data: For each different masonry unit, accessories, integral mortar water repellant and other manufactured product specified.
- C. Samples for selection of the following:
 - 1. Full-sized unit masonry samples showing the full range of colors and textures available for each different exposed masonry unit required.
 - 2. Colored masonry mortar samples showing the full range of colors available.
 - 3. Through-wall flashing.
- D. Shop drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315 "Details and Detailing of Concrete Reinforcement" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement.
- E. Material certificates for the following, signed by manufacturer and Contractor, certifying that each material complies with requirements.
 - 1. Each different cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
 - 2. Each material and grade indicated for reinforcing bars.
 - 3. Each type and size of joint reinforcement.
 - 4. Each type and size of anchors, ties, and metal accessories.
- F. Material test reports from a qualified independent testing agency, employed and paid by Contractor or manufacturer, indicating and interpreting test results relative to compliance of the following proposed masonry materials with requirements indicated:
 - 1. Mortar complying with property requirements of ASTM C 270
 - 2. Mortar complying with BIA M1.
 - 3. Grout mixes. Include description of type and proportions of grout ingredients.
 - 4. Masonry units.

1.5 QUALITY ASSURANCE

- A. Contractor shall employ and pay a qualified professional engineer to provide a survey and inspect foundations for compliance with dimensional tolerances.
- B. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Engineer's satisfaction, based on evaluation or agency-submitted criteria conforming to ASTM C 1093, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- C. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire resistance ratings determined per ASTM

E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

- D. Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one source and by a single manufacturer for each different product required.
- E. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
- F. Field-Constructed Mock-Ups: Prior to installation of unit masonry, erect sample wall panels to further verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-ups to comply with the following requirements, using materials indicated for final unit of Work:
 - 1. Locate Mock-ups on site in locations as directed by Supervising Professional.
 - 2. Build mock-ups for the following types of masonry in sizes of approximately 8 feet long by 12 feet high by full thickness, including face and backup wythes as well as accessories.
 - a. Typical exterior concrete masonry wall with window opening return and banding course.
 - 3. Notify Supervising Professional one week in advance of the dates and times when mock-ups will be erected.
 - 4. Protect mock-ups from the elements with weather-resistant membrane.
 - 5. Retain and maintain mock-ups during construction in undisturbed condition as standard for judging completed unit masonry construction.
 - a. When directed, demolish and remove mock-ups from Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not install until they are in an air-dried condition.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

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

1.7 PROJECT CONDITIONS

- A. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt on completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit masonry damaged by frost or freezing conditions. Comply with the following requirements:
 - 1. Cold-Weather Construction: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. When the ambient temperature is within the limits indicated, use the following procedures:
 - a. 40 to 32 deg F (4 to 0 deg C): Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg F (4 and 49 deg C).
 - b. 32 to 25 deg F (0 to -4 deg C): Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F (4 and 49 deg C). Heat grout materials to produce grout temperatures between 40 and 120 deg F (4 and 49 deg C). Maintain mortar and grout above freezing until used in masonry.
 - c. 25 to 20 deg F (-4 to -7 deg C): Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F (4 and 49 deg C). Heat grout materials to produce grout temperatures between 40 and 120 deg F (4 and 49 deg C). Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F (4 deg C) if grouting. Use heat on both sides of walls under construction.

- d. 20 deg F (-7 deg C) and Below: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F (4 and 49 deg C). Heat grout materials to produce grout temperatures between 40 and 120 deg F (4 and 49 deg C). Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F (4 deg C). Provide enclosures and use heat on both sides of walls under construction to maintain temperatures above 32 deg F (0 deg C) within the enclosures.
- 2. Cold-Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection:
 - a. 40 to 25 deg F (4 to -4 deg C): Cover masonry with a weather-resistant membrane for 48 hours after construction.
 - b. 25 to 20 deg F (-4 to -7 deg C): Cover masonry with insulating blankets or provide enclosure and heat for 48 hours after construction to prevent freezing. Install wind breaks when wind velocity exceeds 15 mi./h (25 km/h).
 - c. 20 deg F (-7 deg C) and Below: Provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after construction.
- E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and above.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following (or approved equal):
 - 1. Concrete Masonry Units:
 - a. County Materials Corporation
 - b. United Brick & Tile, Inc.
 - c. Best Block
 - d. Northfield Block Company
 - e. Trenwyth Industries, Inc.
 - f. Rochester Brick
 - 2. Portland Cement, Mortar Cement, Masonry Cement, and Lime:
 - a. Essroc Materials, Inc.
 - b. Glen-Gery Corporation.
 - c. Lafarge Corporation.
 - d. Lehigh Portland Cement Co.
 - e. Riverton Corporation (The).

3. Mortar Pigments:
 - a. Davis Colors.
 - b. Lafarge Corporation.
 - c. Solomon Grind-Chem Services, Inc.
 - d. Centurion
4. Joint Reinforcement, Ties, and Anchors:
 - a. Dur-O-Wal, Inc.
 - b. Heckman Building Products, Inc.
 - c. Hohmann & Barnard, Inc.
 - d. Masonry Reinforcing Corp. of America.
 - e. National Wire Products Industries.
 - f. Southern Construction Products.

2.2 CONCRETE MASONRY UNITS

- A. General: Provide shapes indicated and as follows for each form of concrete masonry unit required.
 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, except where indicated as bullnose.
 3. Provide bullnose jamb block at all door and window openings.
- B. Basis-of-Design Product: : “Prairie Stone” by Trenwyth Industries, Inc. or a comparable product of one of the manufacturers listed in Article 2.1.
- C. Decorative Concrete Masonry Units: Provide the following units as indicated on the drawings:
 1. Decorative concrete Masonry Unit – Type “A”
 - a. Provide “Rockface” texture concrete masonry units conforming to ASTM C140 for absorption, density, and compressive strength; ASTM C-426 for Shrinkage; and ASTM C-1262 with respect to freezing and thawing.
 - b. 4-inch high x 16-inch wide x thickness indicated on the drawings.
 - c. Color: Buff.
 2. Decorative Concrete Masonry Unit – Type “B”
 - a. Provide “Groundface” texture concrete masonry units conforming to ASTM C140 for absorption, density, and compressive strength; ASTM C-426 for Shrinkage; and ASTM C-1262 with respect to freezing and thawing.
 - b. 8-inches high x 16-inches wide x thickness indicated on the drawings.
 - c. Color: Buff.
 3. Decorative Concrete Masonry Unit – Type “C”
 - a. Provide “Groundface” texture concrete masonry units conforming to ASTM C140 for absorption, density, and compressive strength; ASTM

- C-426 for Shrinkage; and ASTM C-1262 with respect to freezing and thawing.
- b. 16-inches high x 16-inches wide x thickness indicated on the drawings.
 - c. Color: Buff.
4. Concrete Masonry Units: ASTM C90 or ASTM C-145, Grade N-I. All units shall be approved by WI Department of Commerce and as follows:
- a. Normal weight.
 - b. Do not use aggregates made from pumice, scoria, or tuff.
 - c. Provide Type II, non-moisture controlled units.
 - d. Size: Manufactured to the actual dimensions listed below (within tolerances specified in the applicable referenced ASTM specification) for the corresponding nominal sizes indicated on the drawings:
 - 1. 16-inches long x 8-inches high x 6-inches wide, nominal (15-5/8-inches x 7-5/8-inches x 5-5/8-inches actual).
 - 2. 16-inches long x 8-inches high x 8-inches wide, nominal (15-5/8-inches x 7-5/8-inches x 7-5/8-inches actual).
 - 3. 16-inches long x 8-inches high x 12-inches wide, nominal (15-5/8-inches x 7-5/8-inches x 11-5/8-inches actual).
- D. Integral Water Repellent: For units at all exterior exposures, provide units produced with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.

2.3 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
- 1. Do not use calcium chloride in mortar or grout.
 - 2. Add cold-weather admixture (if used) at the same rate for all mortar, regardless of weather conditions, in order to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, and BIA M1, PROPORTION Specification, for job-mixed mortar; and ASTM C 1142 for ready-mixed mortar, of types indicated below:
- 1. Limit cementitious materials in mortar to portland cement and lime.
 - 2. For masonry below grade, in contact with earth, and where indicated, use type indicated below:
 - a. Type: S.
 - 3. For reinforced masonry and where indicated, use type indicated below:

- a. Type: S.
 - 4. For exterior, above-grade, and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions, and for other applications where another type is not indicated, use type indicated below:
 - a. Type: S.
 - 5. For decorative concrete masonry units use the type indicated below:
 - a. Type: S.
- C. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required.
 - 1. Limit pigments to the following percentages of cement content by weight:
 - a. For mineral oxide pigments and portland cement-lime mortar, not more than 10 percent.
 - b. Mix to match Supervising Professional's sample.
- D. Integral Liquid Polymeric Water-repellent Mortar Admixture
 - 1. Description: Integral liquid polymeric admixture, mixed with mortar during mixing, capable of achieving a Class E Rating when evaluated using ASTM E 514 with the test extended to 72 hours, using the rating criteria found in ASTM E 514-74: no decrease in concrete masonry bond strength or compressive strength of prisms when compared to a control when tested according to ASTM C 1357 and ASTM C 1314 respectively.
 - 2. Available Product: Liquid Polymeric Water-repellent Mortar Admixture.
 - 3. Locations: Provide water-repellent mortar admixture at locations where water repellent units are specified.
- E. Grout for Unit Masonry: Comply with ASTM C 476. Use grout of consistency indicated or, if not otherwise indicated, of consistency (fine or coarse) at time of placement that will completely fill spaces intended to receive grout.
 - 1. Use fine grout in grout spaces less than 2 inches (50 mm) in horizontal dimension, unless otherwise indicated.
 - 2. Use coarse grout in grout spaces 2 inches (50 mm) or more in least horizontal dimension, unless otherwise indicated.
- F. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's directions.

2.4 REINFORCING STEEL

- A. Steel Reinforcing Bars: Material and grade as follows:
 - 1. Billet steel complying with ASTM A 615 (ASTM A 615M).

2.5 JOINT REINFORCEMENT

- A. General: Provide joint reinforcement formed from the following:

1. Galvanized carbon-steel wire, coating class as follows:
 - a. ASTM A 153, Class B-2, for both interior and exterior walls.
- B. Description: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet (3 m), with prefabricated corner and tee units, and complying with requirements indicated below:
 1. Wire Diameter for Side Rods: 0.1875 inch.
 2. Wire Diameter for Cross Rods: 0.1875 inch.
- C. For single-wythe masonry, provide type as follows with single pair of side rods:
 1. Truss design with continuous diagonal cross rods, similar to "Truss-Mesh" as manufactured by Hohmann & Barnard Inc., Dur-O-Wal by Dayton Superior, or Wire-Bond. Joint reinforcement shall be spaced not more than 16 inches on center.
- D. For multi-wythe masonry, provide type as follows with single pair of side rods.
 1. Truss design with eye hooks and rectangular pintle. Joint reinforcement shall be spaced not more than 16 inches on center.

2.6 TIES AND ANCHORS, GENERAL

- A. General: Provide ties and anchors, specified in subsequent articles, made from materials that comply with this Article, unless otherwise indicated.
- B. Hot-Dip Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.
- C. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 or 316.
- D. Steel Sheet, Galvanized after Fabrication: ASTM A 366/A 366M cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153.
- E. Stainless-Steel Sheet: ASTM A 666, Type 304 or 316.

2.7 MISCELLANEOUS ANCHORS

- A. Anchor Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations:
 1. Headed bolts.
 2. Nonheaded bolts, bent in manner indicated.

- B. Postinstalled Anchors: Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
1. Type: Chemical anchors.
 2. Type: Expansion anchors.
 3. Type: Undercut anchors.
 4. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).
 5. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.
 6. For Postinstalled Anchors in Concrete: Capability to sustain, without failure, a load equal to four times the loads imposed.
 7. For Postinstalled Anchors in Grouted Masonry Units: Capability to sustain, without failure, a load equal to six times the loads imposed.

2.8 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Fabricate from the following metal complying with requirements specified in Division 7 Section "Sheet Metal Flashing and Trim" and below:
1. Type 304 Stainless Steel Drip Edge: 0.0156 inch (0.4 mm) thick.
 2. Fabricate metal drip edges from sheet metal indicated above. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with a hemmed outer edge bent down 30 degrees.
 3. Available Products: Subject to compliance with requirements, products that may be used:
 - a. Stainless Steel Drip Plate and Terminate Bar by Hohmann & Barnard, Inc.; Dayton Superior; Wire-Bond; or equal.
- B. Concealed Flashing: For flashing partly exposed to the exterior, use metal flashing specified above. For flashing not exposed to the exterior, use the following, unless otherwise indicated:
1. EPDM Flashing: Manufacturer's standard flashing product formed from a terpolymer of ethylene-propylene diene, complying with ASTM D 4637, 0.040 inch (1.0 mm) thick.
 - a. Provide flashing as a complete system with stainless steel termination bars, preformed corners, end dams, other special shapes, and seaming materials; all produced by flashing sheet manufacturer.
 - b. Available Products: Subject to compliance with requirements, products that may be used:
 - 1) EPRA-MAX Through-Wall Flashing with Stainless Steel Drip Plate by Hohmann & Barnard, Inc.; Dayton Superior; Wire-Bond; or equal.

- C. Solder and Sealants for Sheet Metal Flashings: As specified in Division 7 Section "Sheet Metal Flashing and Trim."
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by the flashing manufacturer for bonding flashing sheets to each other and to substrates.
- E. Aluminum Reglet and Counterflashing: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability of alloy and temper designated below:
 - 1. Factory-Painted Aluminum Sheet: ASTM B 209 (ASTM B 209M), 3003-H14, with a minimum thickness of 0.04-inch, unless otherwise indicated.
 - 2. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.
 - 3. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section Joint Sealants.
 - 4. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.
 - 5. High-Performance Organic Coating Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.
 - a. Fluoropolymer 2-Coat Coating System: Manufacturer's standard 2-coat, thermocured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 1402, Test Method No. 7.
 - 1) Color and Gloss: Color to be selected by Supervising Professional.

2.9 SHEET METAL FLASHING FABRICATION, GENERAL

- A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.
- B. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.

- C. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- D. Expansion Provisions: Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- E. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
- F. Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.
- G. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
- H. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
 - 1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.
- I. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and –welded corners and junctions.
 - 1. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
 - 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
 - 3. Available Manufacturers (or approved equal)::
 - a. Cheney Flashing Company, Inc.
 - b. Fry Reglet Corporation.
 - c. Heckmann Building Products, Inc.
 - d. Hickman, W.P. Company.
 - e. Keystone Flashing Company, Inc.
- J. Through-Wall Ribbed Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond. Manufacture through-wall flashing with snaplock receiver on exterior face to receive counterflashing.
 - 1. Available Manufacturers (or approved equal)::

- a. Advanced Building Products, Inc.
- b. Cheney Flashing Company, Inc.
- c. Keystone Flashing Company, Inc.
- d. Hickman, W.P. Company.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Type 2, Class A, Grade 1; compressible up to 35 percent; of width and thickness indicated; formulated from the following material:
 - 1. Neoprene.
- B. Preformed Control-Joint Gaskets: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
 - 1. Styrene-Butadiene Rubber Compound: ASTM D 2000, Designation M2AA-805.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Vinyl Weep Hole/Vent: One-piece, offset, T-shaped units made from flexible, injection-molded PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color approved by Supervising Professional. Available products (or approved equal):
 - 1. Vinyl Weep Hole/Vent:
 - a. Weep Hole Vent; Champion Brick
 - b. Cell Vent; Dur-o-Wal, Inc.
 - c. Williams-Goodco Brick Vent; Williams Products, Inc.
- E. Cavity Drainage Material: 1-inch thick, free-draining mesh; made from polyethylene strands, and shaped to avoid being clogged by mortar droppings. Available products (or approved equal):
 - 1. Cavity Drainage Material:
 - a. Mortar Break; Advanced Building Products, Inc.
 - b. CavClear Masonry Mat; CavClear.
 - c. Mortar Net; Mortar Net USA, Ltd.
 - d. Mortar Stop; Polytite Manufacturing Corp.

2.14 MASONRY CAVITY INSULATION

- A. Extruded Polystyrene Board Insulation: Rigid, cellular, polystyrene thermal insulation with closed cells and integral high-density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with

ASTM C 578, Type IV; in manufacturer's standard lengths and widths; and in thicknesses indicated.

2.15 PROHIBITED MASONRY CLEANERS

- A. Use of chemical cleaning or harsh physical cleaning is not permitted. This includes most manufactured chemical cleaners and masonry cleaning solutions or compounds. Refer to REPAIR, POINTING , AND CLEANING Article in PART 3 for masonry laying and cleaning guidelines.

2.16 SOURCE QUALITY CONTROL

- A. The Owner reserves the right to employ a qualified independent testing agency to perform the following testing for source quality control. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.
- B. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested for strength, absorption, and moisture content per ASTM C 140.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of unit masonry. Do not proceed with installation until unsatisfactory conditions have been corrected.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of unit masonry.
- B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.

3.2 PRE-INSTALLATION CONFERENCE

- A. At least two weeks before the start of above-grade masonry work, the Contractor shall schedule a pre-installation conference at the jobsite to discuss compliance with the requirements of the Contract Documents. Two weeks advance notice shall be given to the participants, who shall include the General Contractor, Mason Contractor, Flashing Installer, CMU Producer and/or the manufacturer of the CMU/Mortar Integral Water-Repellent Admixture. Advise the Supervising Professional of the scheduled meeting date.

3.3 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of thickness indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections of the Specifications.
- C. Leave openings for equipment to be installed before completion of masonry. After installing equipment, complete masonry to match construction immediately adjacent to the opening.
- D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting, where possible. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Mix units for exposed unit masonry from several pallets or cubes as they are placed to produce uniform blend of colors and textures.
- F. All penetrations (pipe, conduit, wiring, etc.) of fire rated walls shall be properly fire stopped with a U.L. listed "Through-penetration Fire Stop Assembly."

3.4 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces of columns, walls, and arrises, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), nor 3/8 inch in 20 feet (10 mm in 6 m), nor 1/2 inch in 40 feet (12 mm in 12 m) or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m), nor 1/2 inch in 40 feet (12 mm in 12 m) or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet (6 mm in 3 m), nor 1/2 inch (12 mm) maximum.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m), nor 1/2 inch in 40 feet (12 mm in 12 m) or more. For top surface of bearing walls, do not exceed 1/8 inch (3 mm) in 10 feet (3 m), nor 1/16 inch (1.5 mm) within width of a single unit.
- C. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls, and partitions, do not exceed 1/2 inch in 20 feet (12 mm in 6 m), nor 3/4 inch in 40 feet (19 mm in 12 m) or more.

- D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4 inch (6 mm) nor plus 1/2 inch (12 mm).
- E. Variation in Mortar-Joint Thickness: Do not vary from bed-joint thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm). Do not vary bed-joint thickness from bed-joint thickness of adjacent course by more than 1/8 inch (3 mm). Do not vary from head-joint thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary head-joint thickness from adjacent head-joint thickness by more than 1/8 inch (3 mm). Do not vary from collar-joint thickness indicated by more than minus 1/4 inch (6 mm) or plus 3/8 inch (10 mm).

3.5 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.
- B. Lay walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.
- C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
 - 1. Match pattern indicated on drawings.
- D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches (50 mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- E. Stopping and Resuming Work: In each course, rack back 1/2-unit length for one-half running bond or 1/3-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar prior to laying fresh masonry.
- F. Built-in Work: As construction progresses, build-in items specified under these special provisions and other appropriate Sections of the Standard Specifications. Fill in solidly with masonry around built-in items.
- G. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

- H. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
- I. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- J. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above and as follows:
 - 1. Install compressible filler in joint between top of partition and underside of structure above.

3.6 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.
 - 2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
 - 3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
 - 4. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 3/8-inch (10-mm) joints.
- B. Lay solid brick-size masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not furrow bed joints or slush head joints.
 - 1. At cavity walls, slope beds toward cavity to minimize mortar protrusions into cavity. As work progress, trowel mortar fins protruding into cavity against cavity face of brick.
- C. Lay hollow brick as follows:
 - 1. Lay vertical-cell units with full head joints, unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
 - 2. Lay horizontal-cell units with full bed joints, unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit in place and one side of unit to be placed.
 - 3. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- 3/8 inch joints.
 - 4. Where epoxy-mortar pointed joints are indicated, rake out setting mortar to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's directions.

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

3.7 CAVITY-WALL INSULATION

- A. On units of plastic board insulation, place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c., both ways on inside face or attach to inside face with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
 - 1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.
- B. During storage and installation, follow good fire safety procedures. Carefully inspect, repair, and replace all broken or damaged inserts prior to final installation.

3.8 RIGID INSULATION

- A. General: Install rigid insulation from in accordance with manufacturer's instructions.

3.9 HORIZONTAL-JOINT REINFORCEMENT

- A. General: Provide continuous horizontal-joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcing a minimum of 6 inches (150 mm).
 - 1. Space reinforcement not more than 16 inches (400 mm) o.c.
 - 2. Space reinforcement not more than 8 inches (200 mm) o.c. in parapet walls.
 - 3. Provide additional reinforcement in mortar joint 1 block course above and below wall openings and extending 12 inches (300 mm) beyond opening.
- B. Cut or interrupt joint reinforcement at movement joints, unless otherwise indicated.
- C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 MOVEMENT JOINTS

- A. General: Install control and expansion joints in unit masonry where indicated on the architectural plans. Build-in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 - 1. Install preformed control-joint gaskets designed to fit standard sash block.
 - 2. Fit bond-breaker strips to hollow contour in ends of block units on one side of control joint. Fill the resultant core with grout and rake joints in exposed faces.
 - 3. Install preformed control-joint gaskets designed to fit standard sash block.
 - 4. Install interlocking units designed for control joints. Install bond-breaker strips at joint.
 - 5. Install temporary foam plastic filler in head joints and remove when unit masonry is complete.
- C. Control joints in fire-rated wall assemblies shall be properly fire-stopped using a U.L. listed "Through-penetration Fire Stop Assembly" designed and listed for the particular application.

3.11 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
 - 1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.
 - 2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches (600 mm) o.c. vertically and 36 inches (900 mm) o.c. horizontally.

3.12 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to metal studs with masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten each anchor section through sheathing to metal studs with 2 metal fasteners of type indicated.
 - 2. Fasten anchors through sheathing to metal studs with metal fasteners of type indicated.
 - 3. Insert anchor section in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
 - 4. Embed tie section in masonry joints. Provide not less than 2-inch (50 mm) air space between back of masonry veneer and face of sheathing.

5. Locate anchor section relative to course where tie section is embedded to allow maximum vertical differential movement of tie up and down.
6. Space anchors as indicated, but not more than 16 inches (400 mm) o.c. vertically and 24 inches (600 mm)o.c. horizontally with not less than 1 anchor for each 2 sq. ft. (0.186 m²) of wall area. Install additional anchors within 12 inches (300 mm) of openings and at intervals around perimeter not exceeding 8 inches (200 mm).

3.13 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and where openings of more than 12 inches (300 mm) for brick size units and 24 inches(600 mm) for block size units are shown without structural steel or other supporting lintels.
 1. Provide precast lintels made from concrete matching concrete masonry units in color, texture, and compressive strength and with reinforcement bars indicated or required to support loads indicated. Cure precast lintels by same method as CMU.
 2. Provide prefabricated or built-in-place masonry lintels. Use specially formed bond beam units with (one), #4 reinforcement bar continuous placed as shown on the plans or lower and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
 3. Provide either of above at Contractor's option or provide precast or formed-in-place concrete lintels complying with requirements of Division 3 Section "Cast-in-Place Concrete."
- C. Provide minimum bearing of 8 inches (200 mm) at each jamb, unless otherwise indicated. Grout cell below bearing as shown in the plans.

3.14 FLASHING, WEEP HOLES, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
- B. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer before covering with mortar.
- C. Install flashing as follows:
 1. At lintels and shelf angles, fasten flashing to concealed walls using continuous metal termination bar. Install continuous backer rod and

- sealant above termination bar, using sealants and fasteners that are compatible with adjacent surfaces.
2. At both sides of heads and sills, use pre-formed end dams that extend flashing up not less than 2 inches (50 mm) to form a watertight pan. Adhere or seal the upturned ends of the sill flashing to direct water that is traveling down the jambs onto the sill flashing.
 3. Install wall base flashing as indicated on the drawings. Follow manufacturer's instructions to install flashing at corners, laps, and splices that accommodate temperature changes and building movement.
 4. Terminate flashing with continuous pre-formed stainless steel drip extending beyond face of wall to prevent water from re-entering masonry.
- D. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing and as follows:
1. Use vinyl weep hole/vents to form weep holes.
 2. Space weep holes 32 inches (600 mm) o.c.
 3. Place cavity drainage material immediately above flashing in cavities, not less than 10 inches (250 mm) high.
 4. In cavities insulated with loose-fill insulation, cover cavity side of open weep holes with plastic insect screening before placing insulation in cavity.
- E. Install vents in vertical head joints at the top of each continuous cavity at spacing indicated. Use vinyl weep hole/vents to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.
 2. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- F. Sheet Metal Flashing Installation
1. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.
 2. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

3. Expansion Provisions: Provide for thermal expansion of exposed sheet metal Work. Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.
 - a. Use joint adhesive for nonmoving joints specified not to be soldered.
5. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.
6. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
7. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashing. Install counterflashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counterflashing joints a minimum of 2 inches (50 mm) and bed with sealant.
8. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
9. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
 - a. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.
10. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions.
 - a. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.

- b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
 - c. Available Manufacturers (or approved equal):
 - i. Cheney Flashing Company, Inc.
 - ii. Fry Reglet Corporation.
 - iii. Heckmann Building Products, Inc.
 - iv. Hickman, W.P. Company.
 - v. Keystone Flashing Company, Inc.
11. Through-Wall Ribbed Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond. Manufacture through-wall flashing with snaplock receiver on exterior face to receive counterflashing.
- a. Available Manufacturers (or approved equal):
 - i. Advanced Building Products, Inc.
 - ii. Cheney Flashing Company, Inc.
 - iii. Keystone Flashing Company, Inc.
 - iv. Hickman, W.P. Company.

3.15 INSTALLATION OF REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.
 - 1. Construct formwork to conform to shape, line and dimensions shown. Make sufficiently tight to prevent leakage of mortar and grout. Brace, tie and support forms to maintain position and shape during construction and curing of reinforce masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
 - 3. Provide cleanout holes at least 3 inches (75 mm) in least dimension for grout pours over 60 inches (1500 mm) in height.
 - a. Provide cleanout holes at each vertical reinforcing bar.
 - b. At solid grouted masonry, provide cleanout holes at not more than 32 inches (800 mm) o.c.
- B. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
 - 1. Do not exceed the following pour heights for fine grout:
 - a. For minimum widths of grout spaces of 3/4 inch (19 mm) or for minimum grout space of hollow unit cells of 1-1/2 by 2 inches (38 by 50 mm), pour height of 12 inches (300 mm).

- b. For minimum widths of grout spaces of 2 inches (50 mm) or for minimum grout space of hollow unit cells of 2 by 3 inches (51 by 76 mm), pour height of 60 inches (1524 mm).
- c. For minimum widths of grout spaces of 2-1/2 inches (63 mm) or for minimum grout space of hollow unit cells of 2-1/2 by 3 inches (63 by 76 mm), pour height of 12 feet (3.6 m).
- d. For minimum widths of grout spaces of 3 inches (76 mm) or for minimum grout space of hollow unit cells of 3 by 3 inches (76 by 76 mm), pour height of 24 feet (7.3 m).

3.16 FIELD QUALITY CONTROL

- A. The Owner may employ and pay a qualified independent testing agency to perform the following testing for field quality control. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.
- B. Testing Frequency: Tests and Evaluations listed in this Article will be performed during construction for each 5000 sq. ft. (465 m²) of wall area or portion thereof.
- C. Mortar properties will be tested per property specification of ASTM C 270.
- D. Prism-Test Method: For each type of wall construction indicated, masonry prisms will be tested per ASTM E 447, Method B, and as follows:
 - 1. Prepare 1 set of prisms for testing at 7 days and 1 set for testing at 28 days.
- E. Evaluation of Quality-Control Tests: In the absence of other indications of noncompliance with requirements, masonry will be considered satisfactory if results from construction quality-control tests comply with minimum requirements indicated.

3.17 INSTALLATION OF WATER-REPELLANT MORTAR ADMIXTURE

- A. Installation: Installer shall use only concrete masonry units containing compatible integral liquid polymeric water-repellent CMU admixture in exterior walls.

3.18 REPAIRING, POINTING, AND CLEANING

- A. All masonry shall be in final acceptance condition within 24 hours after laying and shall be maintained in that condition by meeting or exceeding the degree of cleanliness required, demonstrated on the approved sample panel.
- B. Lay masonry utilizing all necessary care to achieve cleanliness. Remove excess mortar from exposed exterior and interior (stone, clay, concrete and other) masonry surfaces as the work progresses and before it tenaciously adheres to the faces of the masonry. Remove mortar protrusions and smears as masonry units are laid and tooled, as scaffolds are raised, and at the start of the next day's work,

leaving the surface of the masonry clean and finished. Contractor may use calcimine brushes, stiff fiber brushes, other similar masonry units, burlap, rags, carpet remnants, rubber floats or other approved means. Equipment or methods and techniques utilized, reduced productivity, as well as weather conditions experienced will not relieve Contractor of required compliance.

- C. Protection shall be provided to prevent mortar spattering and maintain masonry in a clean condition so that the masonry is satisfactory for acceptance when masonry work is completed. This may require covering portions of finished masonry which is below new work in progress with polyethylene, canvas or other approved means. Cover tops of unfinished walls and new work during inclement weather and at the end of each day's work to prevent moisture entry. Extend covering a minimum of 24 inches down both sides of wall and hold covering securely in place.
- D. No final washdown is required unless removal of earthy construction dirt or dust is necessitated by site conditions.
- E. If any masonry is not cleaned as required by these specifications, or if walls have an unsatisfactory appearance upon completion of work, such violations will require additional work by the Contractor for producing acceptable masonry at no extra cost to the Owner. This is not to be construed as a Contractor's option. Procedures must be submitted by the Contractor and samples approved by all other parties to the contract, prior to proceeding with such work.
- F. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units; install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- G. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point-up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for application of sealants.
- H. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.
- I. Sheet Metal Flashing Cleaning and Protection
 - 1. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
 - 2. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

3.19 MASONRY WASTE DISPOSAL

- A. Recycling: Undamaged, excess masonry materials are Contractor's property and shall be removed from the Project for his use.
- B. Disposal as Fill Material: Dispose of clean masonry waste, including broken masonry units, waste mortar, and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than 4 inches in greatest dimension.
 - 2. Mix masonry waste with at least 2 parts specified fill material for each part masonry waste. Fill material is specified in Division 2 Section "Earthwork."
 - 3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- C. Excess Masonry Waste: Remove excess, clean masonry waste that cannot be used as fill, as described above, and other masonry waste and legally dispose of off Owner's property.

END OF SECTION 04810

1.4. Division 5 – Metals

1.4.1. Section 05120 – Structural Steel

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 structural steel, loose bearing and leveling plates, and masonry lintels.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 5 Section "Steel Deck" for field installation of shear connectors.
 - 2. Division 5 Section "Metal Fabrications" for miscellaneous steel framing.
 - 3. Division 9 Section "Painting" for surface preparation and priming requirements.

1.3 PERFORMANCE REQUIREMENTS

- A. Engineering Responsibility: Engage a fabricator who utilizes a qualified professional engineer to prepare Shop Drawings and other structural data for structural steel connections.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Shop Drawings detailing fabrication of structural steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Provide templates for anchors and bolts for installation.
 - 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 high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.

5. Include Shop Drawings signed and sealed by a qualified professional engineer responsible for their preparation.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Supervising Professionals and owners, and other information specified.
 - E. Mill test reports signed by manufacturers certifying that their products, including the following, comply with requirements.
 1. Structural steel, including chemical and physical properties.
 2. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 3. Direct-tension indicators.
 4. Shop primers.
 5. Nonshrink grout.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage 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.
- B. Fabricator Qualifications: Engage a firm 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.
 1. Fabricator must participate in the AISC Quality Certification Program and be designated an AISC-Certified Plant as follows:
 - a. Category: Category I, conventional steel structures.
 - b. Fabricator shall be registered with and approved by authorities having jurisdiction.
- C. Comply with applicable provisions of the following specifications and documents:
 1. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
 2. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
 3. ASTM A 6 (ASTM A 6M) "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
 4. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is

experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

- E. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel."
 - 1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- F. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 SEQUENCING

- A. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions and directions, as required, for installation. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel Shapes, Plates, and Bars: As follows:
 - 1. Carbon Steel: ASTM A 36 (ASTM A 36M).
 - 2. Stainless Steel: ASTM A 572 (ASTM A 572M)
- B. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.
- C. Anchor Rods, Bolts, Nuts, and Washers: As follows:
 - 1. Headed Bolts: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel, hex-head bolts; and carbon-steel nuts.

2. Headed Bolts: ASTM A 354 (ASTM A 354M), Grade BD, heavy hex steel structural bolts and heavy hex carbon-steel nuts.
 3. Washers: ASTM A 36 (ASTM A 36M).
- D. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
1. Finish: Plain, uncoated.
 2. Finish: Hot-dip zinc-coating, ASTM A 153, Class C.
- E. Welding Electrodes: Comply with AWS requirements.
- F. Galvanized Steel: Provide galvanized steel at exposed surfaces.

2.2 PRIMER

- A. Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664.
- B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

2.4 FABRICATION

- A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.
1. Mark and match-mark materials for field assembly.
 2. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.
 3. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.

4. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 1. Plane thermally cut edges to be welded.
 - C. Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.
 - D. Steel Wall Framing: Select true and straight members for fabricating steel wall framing to be attached to structural steel framing. Straighten as required to provide uniform, square, and true members in completed wall framing.
 - E. Welded Door Frames: Build up welded door frames attached to structural steel framing. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches (250 mm) o.c., unless otherwise indicated.
 - F. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on Shop Drawings.
 1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
 2. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

2.5 SHOP CONNECTIONS

- A. Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 1. Bolts: ASTM A 325 (ASTM A 325M) high-strength bolts, unless otherwise indicated.
 2. Connection Type: Slip-critical, direct-tension, or tensioned shear/bearing connections as indicated.
- B. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

2.6 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections.

4. Surfaces to receive sprayed-on fireproofing.
 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC specifications as follows:
1. SSPC-SP 2 "Hand Tool Cleaning."
 2. SSPC-SP 3 "Power Tool Cleaning."
 3. SSPC-SP 7 "Brush-Off Blast Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply 2 coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Apply a 1-coat, nonasphaltic primer complying with SSPC's "Painting System Guide No. 7.00" to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Color of paint shall be approved by Supervising Professional.

2.7 SOURCE QUALITY CONTROL

- A. General Building Contractor will engage an independent testing and inspecting agency to perform shop inspections and tests and to prepare test reports.
1. Testing agency will conduct and interpret tests and state in each report whether test specimens comply with or deviate from requirements.
 2. Provide testing agency with access to places where structural steel Work is being fabricated or produced so required inspection and testing can be accomplished.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- D. Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. In addition to visual inspection, shop-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.
1. Liquid Penetrant Inspection: ASTM E 165.

2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
4. Ultrasonic Inspection: ASTM E 164.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.
- B. Do not proceed with erection until 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 specifications referenced in this Section.
- B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 3. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
 - a. Comply with manufacturer's instructions for proprietary grout materials.
- 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 forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Finish sections thermally cut during erection equal to a sheared appearance.
- H. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. Install and tighten nonhigh-strength bolts, except where high-strength bolts are indicated.
- B. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.
 - 1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

3.5 FIELD QUALITY CONTROL

- A. General Building Contractor will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

- D. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. In addition to visual inspection, field-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
 - 4. Ultrasonic Inspection: ASTM E 164.

3.6 CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils (0.038 mm).
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on structural steel are included in Division 9 Section "Painting."

END OF SECTION 05120

1.4.2. Section 05500 – Metal Fabrications

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Loose bearing and leveling plates.
 - 2. Loose steel lintels.
 - 3. Steel framing and supports for countertops.
 - 4. Steel framing and supports for mechanical and electrical equipment.
 - 5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 6. Door handle guard fabricated from stainless steel.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-place Concrete".
 - 2. Division 4 Section "Unit Masonry".
 - 3. Division 5 Section "Structural Steel" for structural-steel framing system components.
 - 4. Division 5 Section "Pipe and Tube Railings" for pipe and tube handrails, guardrails, and railings.
 - 5. Division 11 Section "Audio/Visual Accessories" for suspended TV/monitor.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Paint products.
 - 2. Grout.
- B. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 1. Provide templates for anchors and bolts specified for installation under other Sections.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.

- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Supervising Professionals and owners, and other information specified.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Comply with all laws, ordinances, rules, codes and regulations of governmental authorities having jurisdiction over the work.
- D. Comply with AISC Manual, current edition.
 - 1. Code of Standard Practice for Steel Buildings and Bridges.
 - 2. Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.
- E. Specifications for Assembly of Structural Joints Using High Strength Steel Bolts as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
- F. General Requirements for Delivery of Rolled Steel Plated, Shapes and Bars for Structural Use, ASTM A 6.
- G. Provide welding complying with American Welding Society Structural Welding Code for Steel, AWS D1.1.
- H. Qualifications for Welding Work:
 - 1. Qualify welding processes and welding operators in accordance with the AWS, Standard Qualification Procedure.
 - 2. Provide certification that welders to be employed in the work have satisfactorily passed AWS qualification tests within the previous 12 months. Provide recertification of welders as required.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

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.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver fabrications, materials including accessories, anchor bolts, setting and bearing plates to the site at such intervals to ensure uninterrupted progress of the work.
- B. Store fabrications and materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Do not store materials on the structure in a manner that might cause distortion or damage to the members of the supporting structures. Repair or replace damaged materials or structures when so ascertained.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500, Grade B.
- C. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load

imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153.
- D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- E. Steel Plates to be Bent or Formed Cold: ASTM A 283.
- F. Hot Rolled, Rail Carbon Steel Bars and Shapes: ASTM A 499.
- G. Cold-Finished Steel Bars: ASTM A 108.
- H. Steel Pipe: ASTM A 53, Grade B.
- I. Stainless Steel: AISI Type 302/304, with satin stainless finish, 18-gage minimum thickness.

2.3 FASTENERS

- A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36.
- D. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
- E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- F. Wood Screws: Flat head, carbon steel, ASME B18.6.1.
- G. Joist Hangers and Framing Accessories: Simpson, Teco Heckman Building Products.
- H. Plain Washers: Round, carbon steel, ASME B18.22.1 (ASME B18.22M).
- I. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1 (ASME B18.21.2M).

- J. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 593 (ASTM F 738M) and nuts complying with ASTM F 594 (ASTM F 836M).
- K. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

2.4 MICELLANEOUS MATERIALS

- A. Shop Primer for Ferrous Metal: Organic zinc-rich primer, complying with SSPC-Paint 20 and compatible with topcoat.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carboline 621; Carboline Company.
 - b. Aquapon Zinc-Rich Primer 97-670; PPG Industries, Inc.
 - c. Tneme-Zinc 90-97; Tnemec Company, Inc.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint for repairing galvanizing at welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.
- C. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, non-corrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- D. Concrete Fill, Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Shear and punch metals cleanly and accurately. Remove burrs.

- C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- H. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, 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 deg F, ambient; 180 deg F, material surfaces.
- I. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- J. Remove sharp or rough areas on exposed traffic surfaces.
- K. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.6 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

- B. Galvanize plates after fabrication.

2.7 LOOSE STEEL LINTELS

- A. Fabricate loose structural-steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Weld adjoining members together to form a single unit where indicated.
- C. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 8 inches, unless otherwise indicated.
- D. Galvanize loose steel lintels located in exterior walls.

2.8 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports that are not a part of structural-steel framework as necessary to complete the Work.
- B. Fabricate units from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors 1-1/4 inches wide by 1/4 inch thick by 8 inches long at 24 inches o.c., unless otherwise indicated.
 - 3. Furnish inserts if units must be installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.

2.9 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches from each end, 6 inches from corners, and 24 inches o.c., unless otherwise indicated.

- C. Galvanize miscellaneous steel trim in the following locations:
 - 1. Exterior.
 - 2. Interior, where indicated.

2.10 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.11 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123, for galvanizing steel and iron products.
 - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 SETTING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any.
- B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated at girders supported on concrete or masonry, install as specified above for setting and grouting bearing and leveling plates.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified above for setting and grouting bearing and leveling plates.
 - 1. Do not grout baseplates of columns supporting steel girders until girders are installed and leveled.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05500

1.4.3. Section 05521 – Pipe and Tube Railings

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe and tube handrails, railings, and guardrails.
 - 2. Screened gates at dumpsters.
 - 3. Wire cables at railings and guardrails.
- B. Related Sections include the following:
 - 1. Division 5 Section “Metal Fabrications”.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Handrails and Railings: Provide handrails and railings complying with requirements of ASTM E 985 and Wisconsin Administrative Code for structural performance, based on testing performed according to ASTM E 894 and ASTM E 935.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected handrails and railings.
- B. Shop Drawings: Show fabrication and installation of handrails and railings. Include plans, elevations, sections, component details, and attachments to other Work.
- C. Design Calculations: For fabricated items requiring design calculations to substantiate design and installation conditions, prepared, sealed, and signed by a State of Wisconsin Licensed Structural Engineer. Submit design calculations for the following:

1. Handrails, guardrails, and railings.

1.5 QUALITY ASSURANCE

- A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of handrails and railings that are similar to those indicated for this Project in material, design, and extent.
- B. Source Limitations: Obtain each type of handrail and railing through one source from a single manufacturer.

1.6 STORAGE

- A. Store handrails and railings in a dry, well-ventilated, weathertight place.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify handrail and railing dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 COORDINATION

- A. Coordinate installation of anchorages for handrails and railings. 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.

1.9 SCHEDULING

- A. Schedule installation so handrails and railings are mounted only on completed walls. Do not support temporarily by any means that does not satisfy structural performance requirements.

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. Stainless-Steel Wire Rope and Fittings:

- a. Cable Connection (The).
- b. Esmet, Inc.
- c. Feeney Wire Rope & Rigging.
- d. Johnson, C. Sherman, Co., Inc.
- e. Loos & Co. Inc.; Cableware Division.
- f. Sava Industries, Inc.
- g. Seco South, Inc.

2.2 METALS

- A. General: Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.
- B. Steel and Iron: Provide steel and iron in the form indicated, complying with the following requirements:
 - 1. Steel Pipe: ASTM A 53; finish, type, and weight class as follows:
 - a. Type F, or Type S, Grade A, standard weight (Schedule 40), unless another grade and weight are required by structural loads.
 - 2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 3. Iron Castings: Malleable iron complying with ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010).
- C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.
- D. Stainless Steel: Provide stainless steel rope and fittings in the form indicated, complying with the following requirements:
 - 1. Wire Rope: 1-by-19, 3/16-inch diameter wire rope made from wire complying with ASTM A 492, Type 316.
 - 2. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

2.3 WELDING MATERIALS, FASTENERS, AND ANCHORS

- A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Fasteners for Anchoring Handrails and Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads.
 - 1. For steel handrails, railings, and fittings, use plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
 - 2. Dissimilar Metals: Type 304 stainless-steel fasteners.

2.4 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

2.5 FABRICATION

- A. General: Fabricate handrails and railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble handrails and railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Form changes in direction of railing members as follows:
 - 1. By bending.
 - 2. By flush radius bends.
 - 3. By any method indicated above, applicable to change in direction involved.
- D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- E. Welded Connections: Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

- F. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.
- G. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.
- H. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
- I. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.
- J. Close exposed ends of handrail and railing members with prefabricated end fittings.
- K. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of railing and wall is 1/4 inch (6 mm) or less.
- L. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.
- M. Cut, reinforce, drill, and top components as required to receive stainless steel cable system.

2.6 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Provide exposed fasteners with finish matching appearance, including color and texture, of handrails and railings.

2.7 STEEL FINISHES

- A. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For non-galvanized steel handrails and railings, provide non-galvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed handrails and railings:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 7, "Brush-off Blast Cleaning."
- D. Apply shop primer to prepared surfaces of handrail and railing components, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 - 1. Stripe paint edges, corners, crevices, bolts, and welds.
- E. Stainless steel cables: Oil-free, highly polished finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required to install handrails and railings. Set handrails and railings accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.
 - 1. Do not weld, cut, or abrade surfaces of handrail and railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 3. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
- C. Adjust handrails and railings before anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

3.4 ANCHORING POSTS

- A. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.5 ANCHORING RAILING ENDS

- A. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces. Weld flanges to railing ends.

3.6 ATTACHING HANDRAILS TO WALLS

- A. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface.
- B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

3.7 CLEANING & PROTECTION

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."
- B. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.
- C. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05521

1.5. Division 6 – Wood and Plastics

1.5.1. Section 06100 – Miscellaneous Carpentry

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Wood furring, grounds, nailers, and blocking.
 - 2. Wood based structural use panels.
 - 3. Roof sheathing.
 - 4. Closet and utility shelving.
 - 4. Plywood panels for backing.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 6 Section "Interior Architectural Woodwork" for interior wood work not specified in this section.

1.3 DEFINITIONS

- A. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise specified.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.
 - 1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

- A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.

- B. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:
 - 1. NELMA - Northeastern Lumber Manufacturers Association.
 - 2. NLGA - National Lumber Grades Authority (Canadian).
 - 3. RIS - Redwood Inspection Service.
 - 4. SPIB - Southern Pine Inspection Bureau.
 - 5. WCLIB - West Coast Lumber Inspection Bureau.
 - 6. WWPA - Western Wood Products Association.
- C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- D. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 1. Provide dressed lumber, S4S, unless otherwise indicated.
 - 2. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. General: Where lumber or plywood is indicated as preservative treated or is specified to be treated, comply with applicable requirements of AWPB LP-2 Pressure Treatment with Water-Borne Preservatives, AWPB C2 (lumber) and AWPB C9 (plywood). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
 - 1. Do not use chemicals containing chromium, arsenic or petroleum vehicle.
- B. Pressure treat aboveground items with waterborne preservatives to a minimum retention of 0.25 lb/cu. ft. (4.0 kg/cu. m). After treatment, kiln-dry lumber and plywood to a maximum moisture content of 19 and 15 percent, respectively. Treat indicated items and the following:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 - 3. Wood floor plates installed over concrete slabs directly in contact with earth.

- C. 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 (or approved equal):
 - 1. Wood-Preservative-Treated Materials:
 - a. Chemical Specialties, Inc.
 - b. Continental Wood Preservers, Inc.
 - c. Hickson Corp.
 - d. Woodlife Protection Products Manufacturing Company.
 - e. Osmose Wood Preserving, Inc.

2.3 FIRE TREATMENT

- A. All wood members within the building envelope requiring fire treatment shall be in accordance with Standard Specification of Wood Preservers Association to limit flame spread to 25 or less. Furnish UL Certification to Owner.

2.4 DIMENSION LUMBER

- A. General: Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.
- B. Miscellaneous Framing: Provide the following grades and species:
 - 1. Studs and Plates: Stud or No. 3 SPF or better.
 - 2. Headers, Bracing, and Blocking: No. 2 HEM-FIR or better.

2.5 MISCELLANEOUS LUMBER

- A. General: Provide 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.
- B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.
- C. Moisture Content: 19 percent maximum for lumber items not specified to receive wood preservative treatment.
- D. Grade: For dimension lumber sizes, provide No. 3 or Standard grade lumber per ALSC's NGRs of any species. For board-size lumber, provide No. 3 Common grade per NELMA, NLGA, or WWPA; No. 2 grade per SPIB; or Standard grade per NLGA, WCLIB or WWPA of any species.

2.6 ENGINEERED WOOD PRODUCTS

- A. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored

according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.

- B. Extreme Fiber Stress in Bending, Edgewise: 3100 psi (21.3 MPa) for 12-inch nominal- (286-mm actual-) depth members.
- C. Modulus of Elasticity, Edgewise: 2,000,000 psi (13 700 MPa).

2.7 WOOD-BASED STRUCTURAL-USE PANELS, GENERAL

- A. Structural-Use Panel Standards: Provide either all-veneer, mat-formed, or composite panels complying with DOC PS 2, "Performance Standard for Wood-Based Structural-Use Panels," unless otherwise indicated. Provide plywood panels complying with DOC PS 1, "U.S. Product Standard for Construction and Industrial Plywood," where plywood is indicated.
- B. Trademark: Factory mark structural-use panels with APA trademark evidencing compliance with grade requirements.

2.8 ROOF SHEATHING

- A. Plywood Roof Sheathing: Exterior, Structural I sheathing.
- B. Span Rating: Not less than 40/20.
- C. Nominal Thickness: Not less than 5/8 inch.

2.9 STRUCTURAL-USE PANELS FOR BACKING

- A. Plywood Backing Panels: For mounting electrical or telephone and computer equipment, provide fire-retardant-treated plywood panels with grade, C-D Plugged Exposure 1, in thickness indicated or, if not otherwise indicated, not less than 15/32 inch (11.9 mm) thick.

2.10 CLOSET AND UTILITY SHELVING

- A. Dimension Lumber: Provide dimension lumber size and type indicated on the drawings and in compliance with the requirements of Article 2.4 in this specification section.
- B. Plywood Shelving Panels: Provide plywood panels with grade, C-D Plugged Exposure 1, in thickness indicated or, if not otherwise indicated, not less than ¾-inch thick.

2.11 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of Type 304 stainless steel.
- B. Nails, Wire, Brads, and Staples: FS FF-N-105.
- C. Tack: FS FF-N-103.
- D. Power-Driven Fasteners: CABO NER-272.
- E. Wood Screws: FS FF-N-111.
- F. Bolts and studs: FS FF-B-575.
- G. Nuts: FS FF-N-836.
- H. Washers: FS FF-W-92.
- I. Lag Screw or Lag Bolts: FS FF-N-561.
- J. Expansion Shields, Expansion Nails, and Drive Screw Anchors: FS FF-S-325.
- K. Toggle Bolts: FS FF-B-5889.
- L. Bar or Strap Anchors: ASTM A-107 carbon steel.
- M. Hangers and Tie Down Anchors: Manufacturer's standard items for proposed use as detailed. Minimum 18 gauge zinc-coated steel with factory formed holes slightly smaller than nails or screws used.

2.12 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 that is approved for use with type of construction panel indicated by both adhesive and panel manufacturers.
- B. Sill Sealer: Glass fiber wood blanket ½ inch thick or "R-Tite" sill plate gasket by Minnesota Diversified Products, Inc, or Dow "Sill Sill, ¼ inch thick by width of wall framing plates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
- C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.
- D. Apply field treatment complying with AWWA M4 to cut surfaces of preservative-treated lumber and plywood.
- E. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. CABO NER-272 for power-driven staples, P-nails, and allied fasteners.
 - 2. Published requirements of metal framing anchor manufacturer.
 - 3. "Recommended Nailing Schedule" of referenced framing standard and with AFPA's "National Design Specifications for Wood Construction."
- F. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.
- G. Use hot-dip galvanized or stainless-steel nails where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity.

3.2 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

- A. Install wood grounds, nailers, blocking, and sleepers where shown and where required for screeding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

- C. Attach roof edge blocking to substrates where required to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 WOOD FRAMING, GENERAL

- A. Framing Standard: Comply with AFPA's "Manual for Wood Frame Construction," unless otherwise indicated.
- B. Install framing members of size and at spacing indicated.
- C. Do not splice structural members between supports.
- D. Firestop concealed spaces of wood-framed walls and partitions at each floor level and at ceiling line of top story. Where firestopping is not inherent in framing system used, provide closely fitted wood blocks of 2-inch nominal- (38-mm actual-) thickness lumber of same width as framing members.

3.4 FRAMING NAILING SCHEDULE

- A. General: Use cement coated box nails:
 - 1. Sole plate to joists or blocking, face nail – 16d @ 16 inches o.c.
 - 2. Top plate to stud, end nail – 2-16d.
 - 3. Stud to sole plate, toe nail – 4-8d.
 - 4. Doubled Studs, face nail together – 16d @ 24 inches o.c.
 - 5. Doubled top plates, face nail – 16d @ 16 inches o.c.
 - 6. Top plates, laps and intersections, face nail – 2-16d.
 - 7. Continuous header, two pieces – 16d @ 16 inches o.c.

3.6 INSTALLING STRUCTURAL-USE PANELS

- A. Fastening Methods: Fasten panels as indicated below:
 - 1. Plywood Backing Panels: Nail or screw to support. Fasteners exposed to view on the underside of roof sheathing will not be permitted.

END OF SECTION 06100

1.5.2. Section 06192 - Metal-Plate-Connected Wood Trusses

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Triangular-pitched roof trusses.
 - 2. Girder trusses.
 - 3. Truss accessories.
 - 4. Connections of trusses to girder trusses.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 6 Section "Miscellaneous Carpentry" for roof and floor sheathing of structural-use panels and dimension lumber for supplementary framing and permanent bracing.

1.3 DEFINITIONS

- A. Metal-plate-connected wood trusses include planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Engineer, fabricate, and erect metal-plate-connected wood trusses to withstand design loads within limits and under conditions required.
 - 1. Design trusses to withstand design loads without deflections greater than the following:
 - a. Roof Trusses: Vertical deflection of 1/360 of span due to total load.
- B. Engineering Responsibility: Engage a fabricator who uses a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for metal-plate-connected wood trusses.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Shop Drawings detailing location, pitch, span, camber, configuration, and spacing for each type of truss required; species, sizes, and stress grades of lumber to be used; splice details; type, size, material, finish, design values, and orientation and location of metal connector plates; and bearing details.
 - 1. Include design of structural connections of trusses to girder trusses.
 - 2. To the extent truss design considerations are indicated as fabricator's responsibility, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 3. Include 3 additional sets of truss Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation for Architect's submittal to the Department of Commerce - Safety & Buildings.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed wood truss installation similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fabricator's Qualifications: Engage a firm that complies with the following requirements for quality control and is experienced in fabricating metal-plate-connected wood trusses similar to those indicated for this Project and with a record of successful in-service performance:
 - 1. Fabricator participates in a recognized quality-assurance program that involves inspection by SPIB; Timber Products Inspection, Inc.; Truss Plate Institute (TPI); or other independent inspecting and testing agency acceptable to Architect and authorities having jurisdiction.
- C. Comply with applicable requirements and recommendations of the following publications:
 - 1. ANSI/TP1 1, "National Design Standard for Metal-Plate-Connected Wood Truss Construction."
 - 2. TPI HIB "Commentary and Recommendations for Handling Installing & Bracing Metal Plate Connected Wood Trusses."
 - 3. TPI DSB "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."
- D. Metal-Plate Connector Manufacturer's Qualifications: A manufacturer that is a member of TPI and that complies with TPI quality-control procedures for manufacture of connector plates published in ANSI/TPI 1.

- E. Single-Source Responsibility for Connector Plates: Provide metal connector plates from one source and by a single manufacturer.
- F. Wood Structural Design Standard: Comply with applicable requirements of AFPA's "National Design Specification for Wood Construction" and its "Supplement."
- G. Single-Source Engineering Responsibility: Provide trusses engineered by metal-plate connector manufacturer to support superimposed dead and live loads indicated, with design approved and certified by a qualified professional engineer.
- H. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated that have resulted in installing metal-plate-connected wood trusses similar to those indicated for this Project and with a record of successful in-service performance.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store trusses with care and comply with manufacturer's written instructions and TPI recommendations to avoid damage and lateral bending.
- B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

1.8 SEQUENCING AND SCHEDULING

- A. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

PART 2 - PRODUCTS

2.1 DIMENSION LUMBER

- A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
- B. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:
 - 1. NELMA - Northeastern Lumber Manufacturers Association.
 - 2. NLGA - National Lumber Grades Authority (Canadian).
 - 3. SPIB - Southern Pine Inspection Bureau.
 - 4. WWPA - Western Wood Products Association.

- C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- D. Provide dressed lumber, S4S, manufactured to actual sizes required by DOC PS 20 for moisture content specified, to comply with requirements indicated below:
 - 1. Provide dry lumber with 19 percent maximum moisture content at time of dressing.
- E. Grade and Species: Provide dimension lumber of any species for truss chord and web members, graded visually or mechanically, and capable of supporting required loads without exceeding allowable design values according to AFPA's "National Design Specification for Wood Construction" and its "Supplement."

2.2 METAL CONNECTOR PLATES

- A. General: Fabricate connector plates from metal complying with requirements indicated below.
- B. Hot-Dip Galvanized Steel Sheet: Structural-quality steel sheet, zinc coated by hot-dip process complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; Grade 33 and not less than 0.0359 inch (0.91 mm) thick.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified below for material and manufacture.
 - 1. Where truss members are exposed to weather or to high relative humidities, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of stainless steel, Type 304 or 316.
- B. Nails, Wire, Brads, and Staples: FS FF-N-105.
- C. Power-Driven Fasteners: CABO NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts and Screws: ASME B18.2.1 (ASME B18.2.3.8M).
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.4 METAL FRAMING ANCHORS

- A. General: Provide metal framing anchors of structural capacity, type, size, metal, and finish indicated that comply with requirements specified, including the following:
 - 1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.

2.5 FABRICATION

- A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
- B. Fabricate metal connector plates to size, configuration, thickness, and anchorage details required to withstand design loadings for types of joint designs indicated.
- C. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances of ANSI/TPI 1. Position members to produce design camber indicated.
 - 1. Fabricate wood trusses within manufacturing tolerances of ANSI/TPI 1.
- D. Connect truss members by metal connector plates located and securely embedded simultaneously into both sides of wood members by air or hydraulic press.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Do not install wood trusses until supporting construction is in place and is braced and secured.
- B. Before installing, splice trusses delivered to Project site in more than one piece.
- C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

- D. Install and brace trusses according to recommendations of TPI and as required.
- E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- F. Space, adjust, and align trusses in location before permanently fastening and as follows:
 - 1. Truss Spacing: 24 inches (610 mm) o.c.
- G. Anchor trusses securely at all bearing points using metal framing anchors. Install fasteners through each fastener hole in metal framing anchor according to manufacturer's fastening schedules and written instructions.
- H. Securely connect each truss ply required for forming built-up girder trusses.
 - 1. Anchor trusses to girder trusses as designed by truss engineer.
- I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
- J. Install wood trusses within installation tolerances of ANSI/TPI 1.
- K. Do not cut or remove truss members.
- L. Return wood trusses that are damaged or do not meet requirements to fabricator and replace with trusses that do meet requirements.
 - 1. Do not alter trusses in the field.

3.2 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

END OF SECTION 06192

1.5.3. Section 06193 - Open Web Trusses

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A This Section includes the following:
 - 1. Open web roof trusses.
 - 2. Girder trusses.
 - 3. Truss accessories.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 6 Section "Miscellaneous Carpentry" for roof and floor sheathing of structural-use panels and dimension lumber for supplementary framing and permanent bracing.
 - 2. Division 6 Section "Metal-Plate Connected Wood trusses" for other roof framing.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Engineer, fabricate, and erect open web trusses to withstand design loads indicated on the drawings.
 - 1. Design trusses to withstand design loads without deflections greater than the following:
 - a. Roof Trusses: Vertical deflection of 1/360 of span due to total load.
- B. Engineering Responsibility: Engage a fabricator who uses a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for open web trusses.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Shop Drawings detailing location, pitch, span, camber, configuration, and spacing for each type of truss required; species, sizes, and stress grades of lumber to be used; splice details; type, size, material, finish, design values, and orientation and location of metal connector plates; and bearing details.

1. Include design of structural connections of trusses to girder trusses.
2. To the extent truss design considerations are indicated as fabricator's responsibility, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Include 3 additional sets of truss Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation for Architect's submittal to the Department of Commerce - Safety & Buildings.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed wood truss installation similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fabricator's Qualifications: Engage a firm that complies with the following requirements for quality control and is experienced in fabricating open web trusses similar to those indicated for this Project and with a record of successful in-service performance:
 1. Fabricator participates in an industry-recognized quality-assurance program; or other independent inspecting and testing agency acceptable to Architect and authorities having jurisdiction.
- C. Single-Source Engineering Responsibility: Provide trusses engineered by open web truss manufacturer to support superimposed dead and live loads indicated, with design approved and certified by a qualified professional engineer.
- D. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated that have resulted in installing open web trusses similar to those indicated for this Project and with a record of successful in-service performance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store trusses with care and comply with manufacturer's written instructions to avoid damage and lateral bending.
- B. The open-web trusses, if stored prior to installation, shall be stored in a vertical position and protected from the weather. They shall be handled with care so they are not damaged.
- C. They are to be installed in accordance with the plans, and any Fabricator drawings and installation guidelines. Temporary construction loads that cause stresses beyond design limits are not permitted. Installation bracing is to be provided by the Fabricator to keep the trusses straight and plumb as required, and to assure

adequate lateral support for the individual trusses and the entire system until the sheathing material has been applied.

- D. Inspect trusses for discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

1.7 SEQUENCING AND SCHEDULING

- A. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

1.8 WARRANTY

- A. The products delivered shall be free from manufacturing errors or defects in workmanship and material. The products, when correctly installed and maintained, shall be warranted to perform as designed for the normal and expected life of the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The trusses shall be manufactured by Trus Joist, or pre-approved equal. Refer to Substitutions, this Article.
- B. Basis-of-Design Product: The design for the open web trusses is based on the products listed. Subject to compliance with requirements, provide either the named product or a comparable product in accordance with the Article on Substitutions, this section.
 - 1. Series: TJS TRUSS, by Trus Joist.
 - 2. Profile: Tapered.
 - 3. Depth: Minimum depth required to carry load indicated on drawings.
 - 4. Loading – as indicated on drawings.

2.2 MATERIALS

- A. Materials shall comply with ICC ES Legacy Report No. PFC-4354. Chord members, web members, connecting pins and bearing hardware/attachments shall be of material and size as required by design.

2.3 FABRICATION

- A. General: Open web trusses shall be fabricated under the supervision of a third-party inspection agency.

- B. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
- C. Fabricate metal connector plates to size, configuration, thickness, and anchorage details required to withstand design loadings for types of joint designs indicated.
- D. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with industry standard tolerances.

2.4 TOLERANCES

- A. Length bearing to bearing: $\pm 1/8"$ for truss up to 30 ft., $\pm 1/4"$ for truss more than 30 ft.
- B. Depth: $\pm 1/8"$

2.5 IDENTIFICATION

- A. Each of the trusses shall be identified by a stamp indicating the truss series, ICC ES evaluation report number, manufacturer's name, plant number, date of fabrication, and the independent inspection agency's logo.

2.6 SUBSTITUTIONS

- A. Due to the customized detailing and engineering characteristics of the roof framing assembly, it is a requirement that open-web trusses be used.
- B. Substituted products will be permitted if written approval and acceptance is obtained from both architect and owner at least seven working days prior to the bid opening date. Allow a minimum of four working days for review and approval of any submitted substitution.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation Review: Prior to enclosing the trusses, the Contractor shall give notification to the Fabricator's representative to provide an opportunity for review of the installation.
- B. Install trusses in accordance with manufacturer's written instructions.
- C. Do not install trusses until supporting construction is in place and is braced and secured.

- D. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
- E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- F. Space, adjust, and align trusses in location before permanently fastening and as follows:
 - 1. Truss Spacing: 24 inches (610 mm) o.c. unless noted otherwise.
- G. Anchor trusses securely at all bearing points using metal framing anchors. Install fasteners through each fastener hole in metal framing anchor according to manufacturer's fastening schedules and written instructions.
- H. Securely connect each truss ply required for forming built-up girder trusses.
 - 1. Anchor trusses to girder trusses as designed by truss engineer.
- I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
- K. Do not cut or remove truss members.
- L. Return trusses that are damaged or do not meet requirements to fabricator and replace with trusses that do meet requirements.
 - 1. Do not alter trusses in the field.

END OF SECTION 06193

1.5.4. Section 06402 – Interior Architectural Woodwork

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate cabinets.
 - 2. Plastic-laminate countertops.
 - 3. Solid Surface window sills.
 - 4. Solid Surface countertop, accessible counter, and cap trim.
 - 5. Countertop and cabinet hardware and accessories.
- B. Related Sections include the following:
 - 1. Division 6 Section "Miscellaneous Carpentry" for closet and utility shelving, wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

1.3 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items, unless concealed within other construction before woodwork installation.

1.4 SUBMITTALS

- A. Product Data: For high-pressure decorative laminate, solid-surfacing material, cabinet hardware and accessories, and finishing materials and processes.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 2. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, cabling grommets, and other items installed in architectural woodwork.

- C. Samples for Initial Selection: Manufacturer's samples consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.
 - 1. Plastic laminates.
 - 2. Solid Surfaces.
- D. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed architectural woodwork similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Fabricator Qualifications: A firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork, construction, finishes, and other requirements.
 - 1. Provide AWI certification labels or compliance certificate indicating that woodwork complies with requirements of grades specified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.7 PROJECT CONDITIONS

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

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.
2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Products: Comply with the following:
 1. Particleboard: ANSI A208.1, Grade M-2.
- C. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
 - a. Formica Corporation.
 - b. Laminart.
 - c. Pioneer Plastics Corp.
 - d. Wilsonart International; Div. of Premark International, Inc.
- D. Adhesive for Bonding Plastic Laminate: contact cement.
 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.
- E. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without a precoated finish.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avonite; Avonite, Inc.

- b. Corian; DuPont Polymers.
- c. Surell; Formica Corporation.
- d. Fountainhead; International Paper, Decorative Products Division.
- e. Gibraltar; Wilsonart International, Div. of Premark International, Inc.

2.2 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 8 Section "Door Hardware."
- B. Hardware Standard: Comply with BHMA A156.9 for items indicated by referencing BHMA numbers or items referenced to this standard.
- C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening, self-closing.
- D. Back-Mounted Pulls: BHMA A156.9, B02011.
- E. Wire Pulls: Back mounted, 5 inches (127 mm) long, 2-1/2 inches (62 mm) deep, and 5/16 inches (8 mm) in diameter, brushed chrome.
- F. Catches: Magnetic catches, BHMA A156.9, B03141.
- G. Shelf Rests: BHMA A156.9, B04013 (insert pins for holes drilled in cabinet sides).
- H. Drawer Slides: Side-mounted, full-extension, zinc-plated steel drawer slides with steel ball bearings, BHMA A156.9, B05091, and rated for the following loads:
 - 1. Box Drawer Slides: 100 lbf (440 N).
 - 2. File Drawer Slides: 200 lbf (890 N).
- I. Door Locks: BHMA A156.11, E07121.
- J. Drawer Locks: BHMA A156.11, E07041.
- K. Grommets for Cords: 2-1/2-inch diameter. Molded-plastic grommets and matching plastic caps with slot for wire passage and clip on inner wall of liner.
 - 1. Available Product: Subject to compliance with requirements, provide EDP sized "Clipper Gripper" by Doug Mockett and Co., Inc.; Weber Knapp; Lab Safety Supply; or approved equal.
 - 2. Color to be selected by Supervising Professional from manufacturer's full range of colors.
- L. Vent: Grilles: Mesh air vent with frame. Size as indicated on the drawings.

1. Available Product: Subject to compliance with requirements, provide GT Series Air Vent Grilles by Doug Mockett and Co., Inc.; Weber Knapp; Lab Safety Supply; or approved equal.
 2. Color to be selected by Supervising Professional from manufacturer's full range of colors.
- M. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for finish indicated.
- N. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.3 INSTALLATION MATERIALS

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

2.4 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Provide Custom grade interior woodwork complying with the referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Fabricate woodwork to dimensions, profiles, and details indicated.
- D. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

2.5 PLASTIC-LAMINATE CABINETS

- A. Quality Standard: Comply with AWI Section 400 requirements for laminate cabinets.
- B. Grade: Custom.
- C. AWI Type of Cabinet Construction: Flush overlay.

- D. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 - 1. Horizontal Surfaces Other Than Tops: HGS.
 - 2. Postformed Surfaces: HGP.
 - 3. Vertical Surfaces: HGS.
 - 4. Edges: HGS.
- E. Materials for Semi-exposed Surfaces: Provide surface materials indicated below:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS.
 - 2. Drawer Sides and Backs: Thermoset decorative overlay.
 - 3. Drawer Bottoms: Thermoset decorative overlay.
- F. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Provide Supervising Professional's selections from laminate manufacturer's full range of colors and finishes in the following categories:
 - a. Solid colors.
 - b. Patterns.

2.6 PLASTIC-LAMINATE COUNTERTOPS

- A. Quality Standard: Comply with AWI Section 400 requirements for high-pressure decorative laminate countertops.
- B. Grade: Custom.
- C. High-Pressure Decorative Laminate Grade: HGS.
- D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Provide Supervising Professional's selections from manufacturer's full range of colors and finishes in the following categories:
 - a. Solid colors.
 - b. Patterns.
- E. Edge Treatment: Same as laminate cladding on horizontal surfaces.
- F. Core Material: Particleboard or medium-density fiberboard.
- G. Core Material at Sinks: Particleboard made with exterior glue.

2.7 SOLID-SURFACE SILLS, COUNTERTOPS, TRIM

- A. Quality Standard: Comply with AWI Section 400 requirements for countertops.
- B. Grade: Custom.
- C. Solid-Surfacing-Material Thickness: 1/2 inch or as indicated on the drawings.
- D. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
 - 1. Provide Supervising Professional's selections from manufacturer's full range of colors and finishes.
- E. Fabricate counter tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Quality Standard: Install woodwork to comply with AWI Section 1700 for the same grade specified in Part 2 of this Section for type of woodwork involved.
- B. Install woodwork components level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
- C. Scribe and cut woodwork components to fit adjoining work, and refinish cut surfaces and repair damaged finish at cuts.
- D. Anchor woodwork components to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation, per the manufacturer's instructions. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

- E. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for 1-inch (25-mm) penetration into wood framing, blocking, or hanging strips.
- F. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 3. Caulk space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."
- G. Refer to Division 9 Sections for final finishing of installed architectural woodwork.

3.3 ADJUSTING AND CLEANING

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

END OF SECTION 06402

1.6. Division 7 – Thermal and Moisture Protection

1.6.1. Section 07131 – Self-Adhering Sheet Waterproofing

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Rubberized-Asphalt Sheet Waterproofing at the static scale access tunnel.

1.3 RELATED SECTIONS

- A. The following sections relate to this section:
 - 1. Division 2 Section "Earthwork".
 - 2. Division 3 Sections "Cast in Place Concrete".

1.4 PERFORMANCE REQUIREMENTS

- A. Provide waterproofing that prevents the passage of water.

1.5 SUBMITTALS

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
- B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
 - 1. Include Setting Drawings showing layout, sizes, sections, profiles, and joint details of concrete pavers with paver support assemblies.
- C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
- D. Product Test Reports: From a qualified independent testing agency indicating and interpreting test results of waterproofing for compliance with requirements, based on comprehensive testing of current waterproofing formulations.

- E. Sample Warranty: Copy of special waterproofing manufacturer's and Installer's warranty stating obligations, remedies, limitations, and exclusions before starting waterproofing.
- F. Pre-installation conference: Schedule a pre-installation meeting before excavation with the Supervising Professional, General Building Contractor, and Subcontractors for Waterproofing, Concrete casting, Backfill, formwork and excavating. Meeting shall review the following:
 - 1. Width of excavation to allow adequate space for positive side waterproofing;
 - 2. Sequencing of concrete casting and backfilling;
 - 3. Waterproofing contractor's review of required concrete finishes and moisture requirements.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who is authorized, approved, or licensed by waterproofing manufacturer to install manufacturer's products.
- B. Source Limitations: Obtain waterproofing materials, protection course, and molded-sheet drainage panels through one source from a single manufacturer.
- C. Mockups: Apply waterproofing to 100 sq. ft. (9.3 sq. m) of deck and wall to demonstrate surface preparation, crack and joint treatment, corner treatment, and execution quality.
 - 1. If Supervising Professional determines mockups do not comply with requirements, reapply waterproofing until mockups are approved.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Store rolls according to manufacturer's written instructions.
- E. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
 - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.9 WARRANTY

- A. Special Manufacturer's Warranty: Written warranty, signed by waterproofing manufacturer agreeing to replace waterproofing material that does not comply with requirements or that does not remain watertight during specified warranty period.
 - 1. Warranty does not include failure of waterproofing due to failure of substrate prepared and treated according to requirements or formation of new joints and cracks in substrate exceeding 1/16 inch (1.6 mm) in width.
 - 2. Warranty Period: Five years after date of Substantial Completion.
- B. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering Work of this Section, for warranty period of two years.
 - 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, and site restoration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Product: The design is based on the system named. Subject to compliance with requirements, provide either the named system or a comparable product by one of the other manufacturers specified (or approved equal):
 - 1. Rubberized-Asphalt Sheet Waterproofing:
 - a. W. R. Grace & Co.; Bituthene 4000.
 - b. American Hydrotech, Inc.; VM 75.
 - c. American Permaquik Inc.; PQ 7100.
 - d. Carlisle Corporation, Carlisle Coatings & Waterproofing Div.; CCW 701.
 - e. Cetco; Envirosheet.
 - f. W. R. Grace & Co.; Bituthene.
 - g. W. R. Meadows, Inc.; Mel-Rol.
 - h. T. C. Miradri; Miradri.
 - i. Monsey Bakor; Elasto-Seal 2000.
 - j. Pecora Corporation; Duramem 700-SM.

- k. Polyguard Products, Inc.; Polyguard 650.
- l. Progress Unlimited, Inc.; Plastiwrap 60.
- m. Tamko Roofing Products, Inc.; TW-60.

2.2 RUBBERIZED-ASPHALT SHEET WATERPROOFING

- A. Rubberized-Asphalt Sheet: 60-mil- (1.5-mm-) thick, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated to a 4-mil- (0.10-mm-) thick, polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
 - 1. Physical Properties: As follows, measured per standard test methods referenced:
 - a. Tensile Strength: 250 psi (1.7 MPa) minimum; ASTM D 412, Die C, modified.
 - b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
 - c. Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D 1970.
 - d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C 836.
 - e. Puncture Resistance: 40 lbf (180 N) minimum; ASTM E 154.
 - f. Hydrostatic-Head Resistance: 150 feet (45 m) minimum; ASTM D 5385.
 - g. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D 570.
 - h. Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m); ASTM E 96, Water Method.

2.3 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
 - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of sheet waterproofing material.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.
- D. Sheet Strips: Self-adhering, rubberized-asphalt composite sheet strips of same material and thickness as sheet waterproofing.

- E. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, trowel grade or low viscosity.
- F. Substrate Patching Membrane: Low-viscosity, two-component, asphalt-modified coating.
- G. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.
 - 1. Detail Tape: Two-sided, pressure-sensitive, self-adhering reinforced tape, 4-1/2 inches (114 mm) wide, with a tack-free protective adhesive coating on one side and release film on self-adhering side.
 - 2. Detail Strips: 62.5-mil- (1.58-mm-) thick, felt-reinforced self-adhesive strip, 9 inches (230 mm) wide, with release film on adhesive side.
- H. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick, predrilled at 9-inch (225-mm) centers.
- I. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578 Type X, 2 inches thick.

2.4 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to 1 side and a polymeric film bonded to the other side of a 3-dimensional, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
 - 1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
 - 2. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 3. Verify that compacted subgrade is dry, smooth, and sound; ready to receive HDPE sheet.
 - 4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
- F. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips.
 - 1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
 - 1. Install membrane strips centered over vertical inside corners. Install 3/4-inch (19-mm) fillets of liquid membrane on horizontal inside corners and as follows:
 - a. At footing-to-wall intersections, extend liquid membrane each direction from corner or install membrane strip centered over corner.
 - b. At plaza deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.
- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

3.3 RUBBERIZED-ASPHALT SHEET APPLICATION

- A. Install self-adhering sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.
- B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
 - 1. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, rubberized-asphalt sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F (16 deg C).
- D. Horizontal Application: Apply sheets from low point to high point of decks to ensure that side laps shed water.
- E. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.
- F. Seal exposed edges of sheets at terminations not concealed by metal counterflashings or ending in reglets with mastic or sealant.
- G. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.
- H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheets extending 6 inches (150 mm) beyond repaired areas in all directions.
- I. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements, repair substrates, reapply waterproofing, and repair sheet flashings.

3.4 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

- A. Place and secure molded-sheet drainage panels according to manufacturer's written instructions. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. For vertical applications, install board insulation used as a protection course before installing drainage panels.

3.5 FIELD QUALITY CONTROL

- A. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

3.6 PROTECTION AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Protect installed drainage panels from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07131

1.6.2. Section 07210 – Building Insulation

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Foundation wall insulation supporting backfill.
 - 2. Concealed building insulation.
 - 3. Vapor retarders.
 - 4. Nailable Polyisocyanurate Board Insulation.
- B. Related Sections include the following:
 - 1. Division 4 Section "Unit Masonry Assemblies" for insulation installed in unit masonry.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of building insulation through one source.
- B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface-Burning Characteristics: ASTM E 84.
 - 2. Fire-Resistance Ratings: ASTM E 119.
 - 3. Combustion Characteristics: ASTM E 136.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (or approved equal):
 1. Extruded-Polystyrene Board Insulation:
 - a. Celotex.
 - b. DiversiFoam Products.
 - c. Dow Chemical Company.
 - d. Owens Corning.
 - e. Tenneco Building Products.
 2. Glass-Fiber Insulation:
 - a. CertainTeed Corporation.
 - b. Johns Manville Corporation.
 - c. Knauf Fiber Glass.
 - d. Owens Corning.
 3. Nailable Polyisocyanurate Board Insulation:
 - a. Celotex.
 - b. Celo-Vent.
 - c. Rmax Nailable Base-3.
 - d. Approved equal.

2.2 INSULATING MATERIALS

- A. General: Provide insulating materials that comply with requirements and with referenced standards.
 1. Preformed Units: Sizes to fit applications indicated; selected from manufacturer's standard thicknesses, widths, and lengths.
- B. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indices of 75 and 450, respectively:
 1. At Foundation Walls Supporting Backfill: Type IV, 1.60 lb/cu. ft. (26 kg/cu. m), unless otherwise indicated. Available products include:
 - a. Foamular 250 by Owens Corning.
 - b. Styrofoam Square Edge by Dow Chemical Company.
 - c. Certifoam 25 SE by Diversifoam Products.
- C. Unfaced Mineral-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from glass; with

maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

- D. Nailable Polyisocyanurate Board Insulation: Rigid, cellular polyisocyanurate thermal insulation with core formed by using HCFC's as blowing agents to comply with ASTM C 1289, securely bonded to a top layer of 7/16" oriented structural board (OSB) with manufacturer's standard facing on the other face.

2.3 VAPOR RETARDERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Reinforced-Polyethylene Vapor Retarders:
 - a. Raven Industries, Inc.; DURA-SKRIM 6WW.
 - b. Reef Industries, Inc.; Griffolyn T-65.
- B. Polyethylene Vapor Retarder: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
- C. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.4 AUXILIARY INSULATING MATERIALS

- A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

- B. Close off openings in cavities receiving poured-in-place insulation to prevent escape of insulation. Provide bronze or stainless-steel screens (inside) where openings must be maintained for drainage or ventilation.

3.3 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice and snow.
- C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Water-Piping Coordination: If water piping is located on inside of insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
- E. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

- A. On vertical surfaces, set units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.
 - 1. If not indicated, extend insulation a minimum of 48 inches below exterior grade line.

3.5 INSTALLATION OF GENERAL BUILDING INSULATION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Seal joints between closed-cell (non-breathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Install mineral-fiber blankets in cavities formed by framing members according to the following requirements:

1. Use blanket widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
 2. Place blankets in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping stapling flanges to flanges of metal studs.
- D. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
 2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
 4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.6 INSTALLATION OF VAPOR RETARDERS

- A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs. Fasten vapor retarders to framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches (406 mm) o.c.
- C. Seal overlapping joints in vapor retarders with adhesives or vapor-retarder tape according to vapor-retarder manufacturer's instructions. Seal butt joints and fastener penetrations with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
- D. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor-retarder manufacturer.

- E. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.
- F. Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

3.7 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07210

1.6.3. Section 07411 – Manufactured Roof Panels

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Standing-seam roof panels.
 - 2. Seam-Mounted Snow Guards.
 - 3. Roof underlayment material.
 - 4. Aluminum soffit material.
- B. Related Sections include the following:
 - 1. Division 5 Section "Structural Steel" for structural-steel framing.
 - 2. Division 6 Section "Miscellaneous Carpentry" for roof sheathing, blocking, nailers, and grounds.
 - 3. Division 7 Section "Sheet Metal Flashing and Trim" for flashing not part of roofing and other sheet metal work.
 - 4. Division 7 Section "Joint Sealants" for field-applied sealants.
 - 5. Division 7 Section "Building Insulation" for nailable insulation.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide manufactured roof panel assemblies complying with performance requirements indicated and capable of withstanding structural movement, thermally induced movement, and exposure to weather without failure or infiltration of water into the building interior.
- B. Air Infiltration: Provide manufactured roof panel assemblies with permanent resistance to air leakage through assembly of not more than 0.09 cfm/sq. ft. (0.45 L/s/sq. m) of fixed roof area when tested according to ASTM E 1680 at a static-air-pressure difference of 4.0 lbf/sq. ft. (192 Pa).
- C. Water Penetration: Provide manufactured roof panel assemblies with no water penetration as defined in the test method when tested according to ASTM E 1646 at a minimum differential pressure of 20 percent of inward acting, wind-load design pressure of not less than 6.24 lb/sq. ft. (300 Pa) and not more than 12.0 lb/sq. ft. (575 Pa).

- D. Wind-Uplift Resistance: Provide roof panel assemblies that meet requirements of UL 580 for Class 90 wind-uplift resistance.
- E. Structural Performance: Provide manufactured roof panel assemblies capable of safely supporting design loads indicated under in-service conditions with vertical deflection no greater than the following, based on testing manufacturer's standard units according to ASTM E 1592 by a qualified independent testing and inspecting agency.
 - 1. Maximum Deflection: 1/180 of the span.

1.4 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each types of metal roof panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorage, trim, flashings, closures, and accessories; and special details. Distinguish between factory and field-assembled work. Include details of the following items:
 - 1. Flashing and trim.
 - 2. Gutters and downspouts.
 - 3. Snow guards.
- C. Samples for Initial Selection: Manufacturer's color charts or chips showing the full range of roof, soffit, and snow guard colors, textures, and patterns available for roof panels with factory-applied finishes.
- D. Samples for Verification: Provide roof and soffit sample panels 12 inches (300 mm) long by actual panel width, in the profile, style, color, and texture indicated. Include clips, caps, battens, fasteners, closures, and other exposed panel accessories.
- E. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed metal roof panel projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver panels and other components so they will not be damaged or deformed. Package panels for protection against damage during transportation or handling.

- B. Handling: Exercise care in unloading, storing, and erecting roof panels to prevent bending, warping, twisting, and surface damage.
- C. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight and ventilated covering. Store panels to ensure dryness. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify location of structural members and openings in substrates by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Finish Warranty: Submit a written warranty, signed by manufacturer, covering failure of the factory-applied exterior finish on metal roof panels within the specified warranty period and agreeing to repair finish or replace roof panels that show evidence of finish deterioration. Deterioration of finish includes, but is not limited to, color fade, chalking, cracking, peeling, and loss of film integrity.
- C. Finish Warranty Period: 20 years from date of Substantial Completion.
- D. Special Weathertight Warranty: Submit a written warranty executed by manufacturer agreeing to repair or replace metal roof panel assembly that fails to remain weathertight within the specified warranty period.
- E. Weathertight Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Product: Specification is based on Pac-Clad "Snap-Clad Panel" System by Petersen Aluminum Corp.

- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering metal panels that may be incorporated into the Work include, but are not limited to, the following:
1. Aluminum Roof Panels:
 - a. Architectural Building Components.
 - b. McElroy Metal, Inc.
 - c. Petersen Aluminum Corp.
 - d. Englert, Inc.

2.2 ALUMINUM ROOFING PANELS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M) for alclad alloy 3003 or 3004, with temper as required to suit forming operations and complying with the following requirements:
1. Surface: Smooth, flat, mill finish.
 2. Alternative alloys include 1100; alclad 3003, 3004, 3105, 5005, and 5050; in A14, H14, H24, H32, or H34 temper.
 3. Thickness: 0.032 inch, unless otherwise indicated.
 4. High-Performance Organic Coating Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.
 - a. Fluoropolymer 2-Coat Coating System: Manufacturer's standard 2-coat, thermocured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 1402, Test Method No. 7.
 - 1) Color and Gloss: As selected by Supervising Professional from Manufacturer's full range of colors.
 5. Panel Coverage: 16 inches.
 6. Seam Height: 1.75 inches.
 7. Uplift rating: UL 90.

2.3 ROOF PANEL ASSEMBLIES

- A. Standing-Seam Roof Panels: Manufacturer's standard factory-formed, standing-seam roof panel assembly designed for concealed mechanical attachment of panels to roof purlins or deck.
1. Clips: Provide minimum 0.0625-inch- (1.6-mm-) thick, stainless-steel panel clips designed to meet negative-load requirements.
 2. Cleats: Mechanically seamed cleats formed from minimum 0.0250-inch- (0.65-mm-) thick, stainless-steel or nylon-coated aluminum sheets.

2.4 UNDERLAYMENT MATERIALS

- A. Self-Adhering, Polymer-Modified, Bituminous sheet underlayment: ASTM D 1970, minimum of 40 mils thick. Provide primer when recommended by underlayment manufacturer.
 - 1. Available Products: Subject to compliance with requirements, products that maybe incorporated into the work include, but are not limited to, the following (or approved equal):
 - a. WinterGuard; Certain Teed Corporation
 - b. Weather Watch; GAF Building Materials Corp.
 - c. Celotex Inc.

2.5 MISCELLANEOUS MATERIALS

- A. General: Provide materials and accessories required for a complete roof panel assembly and as recommended by panel manufacturer, unless otherwise indicated.
- B. Thermal Spacers: Where panels attach directly to purlins, provide thermal spacers recommended by panel manufacturer.
- C. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.
 - 1. Use aluminum or stainless-steel fasteners for exterior applications and aluminum or galvanized steel fasteners for interior applications.
 - 2. Provide exposed fasteners with heads matching color of panel by means of plastic caps or factory-applied coating.
 - 3. Provide metal-backed neoprene washers under heads of exposed fasteners bearing on weather side of panels.
 - 4. Locate and space exposed fasteners in true vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of neoprene washer.
- D. Accessories: Unless otherwise specified, provide components required for a complete roof panel assembly including trim, copings, fascia, mullions, sills, corner units, ridge closures, clips, seam covers, battens, flashings, gutters, sealants, gaskets, fillers, closure strips, and similar items. Match materials and finishes of panels.
 - 1. Closure Strips: Closed-cell, self-extinguishing, expanded, cellular, rubber or cross-linked, polyolefin-foam flexible closure strips. Cut or premold to match configuration of panels. Provide closure strips where indicated or necessary to ensure weathertight construction.
 - 2. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, non-sag, nontoxic, nonstaining tape.
 - 3. Elastomeric Joint Sealant: ASTM C 920, of base polymer, type, grade, class, and use classifications required to seal joints in panel roofing and

remain weathertight. Provide sealant recommended by panel manufacturer.

- E. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat, unless otherwise indicated. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- F. Expansion-Joint Sealant: For hooked-type expansion joints that must be free to move, provide non-setting, non-hardening, non-migrating, heavy-bodied polyisobutylene sealant.

2.6 FABRICATION

- A. General: Fabricate and finish panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Fabricate panel joints with captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.

2.6 PANEL SUPPORTS AND ANCHORAGE

- A. Secondary Framing: Provide components complying with the Light Gage Structural Institute's "Guide Specifications," Section 07410, "Manufactured Roof and Wall Panels."
 - 1. Roof Purlins: C- or Z-shaped sections fabricated from 0.0598-inch- (1.5-mm-) thick, shop-painted, roll-formed steel. Purlin spacers fabricated from 0.079-inch- (2.0-mm-) thick, cold-formed, galvanized steel sections.
 - 2. Eave Struts: Unequal flange, C-shaped sections formed to provide adequate back-up for roof panels. Fabricate from 0.0598-inch- (1.5-mm-) thick, shop-painted, roll-formed steel.
 - 3. Flange and Sag Bracing: 1-5/8-by-1-5/8-inch (41-by-41-mm) angles, fabricated from 0.0598-inch- (1.5-mm-) thick, shop-painted, roll-formed steel.
 - 4. Base or Sill Angles: Fabricate from 0.079-inch- (2.0-mm-) thick, cold-formed, galvanized steel sections.
 - 5. Secondary structural members, except columns and beams, shall be manufacturer's standard sections fabricated from 0.079-inch- (2.0-mm-) thick, cold-formed galvanized steel.

2.7 SEAM-MOUNTED, BAR-TYPE SNOW GUARDS

- A. Prefabricated, non-corrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hoods for anchoring. Product shall be compatible with roofing panels.
 - 1. Seam-Mounted, Bar-Type Snow Guards: Aluminum rods or bars held in place by stainless-steel clamps attached to vertical ribs of standing-seam metal roof panels.
 - a. Aluminum Finish: High performance organic finish, AAMA 605.2, multiple coat, thermally cured fluoropolymer system.
 - b. Color: Custom color, match color selected by the Supervising Professional.
 - c. Material: Aircraft grade aluminum tubing, 1 inch O.D.
 - d. Tubing Shape: D shaped, to prevent rotation in brackets.
 - e. Bracket Spacing: 16 inches on center.
 - 2. Available Products:
 - a. Snow Management System, a Division of Contek, Inc., 699 Harrel Street, Morrisville, Vermont; Phone 802-888-7100
MODEL NO. – LIT2P-716 (2 Pipe Standing Seam)
 - b. Alpine Snow Guards, P.O. Box 430, Stowe, VT 05672-0430; Phone 1-888-766-4273 Model No. 4000
 - c. Mullane:M.J.Mullane Co., Inc.
 - d. Or approved equal.
 - 3. Manufacturer shall provide test data indicating the load capacity of their product.

2.8 ALUMINUM SOFFIT PANELS

- A. 0.032 Aluminum. 12-inch wide, flush soffit panel, 3-equal spans.
- B. Color: Match roofing panels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements indicated for conditions affecting performance of metal panel roofing.
 - 1. Panel Supports and Anchorage: Examine roof framing to verify that purlins, angles, channels, and other secondary structural panel support members and anchorage have been installed according to written instructions of panel manufacturer.
 - 2. Do not proceed with roof panel installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate metal panel roofing with rain drainage work; flashing; trim; and construction of decks, parapets, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.
- B. Promptly remove protective film, if any, from exposed surfaces of metal panels. Strip with care to avoid damage to finish.
- C. Secondary Structural Supports: Install purlins, bracing, and other secondary structural panel support members and anchorage according to the Light Gage Structural Institute's "Guide Specifications," Section 07410, "Manufactured Roof and Wall Panels."

3.3 PANEL INSTALLATION

- A. General: Comply with panel manufacturer's written instructions and recommendations for installation, as applicable to project conditions and supporting substrates. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Field cutting exterior panels by torch is not permitted.
 - 2. Install panels with concealed fasteners, unless otherwise indicated.
 - 3. Install panels over solid substrate with minimum 3:12 (1:4) slope. Install 1 ply of felt from lower edge up, with at least 3-inch (75-mm) side laps and 4-inch (100-mm) end laps.
- B. Accessories: Install components required for a complete roof panel assembly including trim, copings, fasciae, ridge closures, clips, seam covers, battens, flashings, gutters, sealants, gaskets, fillers, closure strips, and similar items. Coordinate as required with other products.
- C. Separate dissimilar metals by painting each metal surface in area of contact with a bituminous coating, by applying rubberized-asphalt underlayment to each metal surface, or by other permanent separation as recommended by manufacturers of dissimilar metals.
- D. Install felt underlayment, Bituminous sheet underlayment and building-paper slip sheet on roof deck under metal panels, unless otherwise recommended by panel manufacturer. Use adhesive for temporary anchorage, where possible, to minimize use of mechanical fasteners under metal panels. Apply from eave to ridge in shingle fashion and lap joints a minimum of 2 inches (50 mm).
- E. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not otherwise indicated, types recommended by panel manufacturer.

1. Install weatherseal under ridge cap. Flash and seal panels at eave and rake with rubber, neoprene, or other closures to exclude weather.
 2. Seal panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by panel manufacturer.
- F. Standing-Seam Roof Panel Assembly: Fasten panels to supports with concealed clip according to panel manufacturer's written instructions.
1. Install clips at each support with self-drilling/self-tapping fasteners.
 2. At end laps of panels, install tape calk between panels.
 3. Install factory-calked cleats at standing-seam joints. Apply snap-on batten to panels to provide a weathertight joint.
- G. Installation Tolerances: Shim and align panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- H. Bar-Type Snow Guards
1. Attached bar supports to vertical ribs of standing-seam metal roof panels with clamps or set screws. Do not use fasteners that will penetrate metal roof panels.
 2. Provide snow guards at locations indicated on the drawings.

3.4 CLEANING AND PROTECTING

- A. Damaged Units: Replace panels and other components of the Work that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- B. Cleaning: Remove temporary protective coverings and strippable films, if any, as soon as each panel is installed. On completion of panel installation, clean finished surfaces as recommended by panel manufacturer and maintain in a clean condition during construction.

END OF SECTION 07411

1.6.4. Section 07620 – Sheet Metal Flashing & Trim

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following sheet metal flashing and trim:
 - 1. Formed steep-slope roof flashing and trim.
- B. Related Sections include the following:
 - 1. Division 4 Section "Unit Masonry Assemblies" for installing through-wall flashing, reglets, and other sheet metal flashing and trim.
 - 2. Division 6 Section "Miscellaneous Carpentry" for wood nailers, curbs, and blocking.
 - 3. Division 7 Section "Manufactured Roof Panels" for factory-formed metal roof panels and flashing and trim not part of sheet metal flashing and trim.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- C. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include the following:
 - 1. Identify material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 - 3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
 - 4. Details of expansion-joint covers, including showing direction of expansion and contraction.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Sheet Metal Flashing: 12 inches (300 mm) long. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim: 12 inches (300 mm) long. Include fasteners and other exposed accessories.
 - 3. Accessories: Full-size Sample.

1.5 QUALITY ASSURANCE

- A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
- B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.7 COORDINATION

- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 SHEET METALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14.
 - 1. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 1402, Test Method No. 7.
 - 1) Color and Gloss: As selected by Supervising Professional from Manufacturer's full range of colors.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- C. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality, mill phosphatized for field painting.

2.3 UNDERLAYMENT MATERIALS

- A. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
- B. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

2.5 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Drip Edges: Fabricate from the following material:
 - 1. Aluminum: 0.0320 inch (0.8 mm) thick.
- B. Eave, Rake, Ridge Flashing: Fabricate from the following material:
 - 1. Aluminum: 0.0320 inch (0.8 mm) thick.
- C. Base Flashing: Fabricate from the following material:
 - 1. Aluminum: 0.040 inch (1.0 mm) thick.
- D. Counterflashing: Fabricate from the following material:
 - 1. Aluminum: 0.0320 inch (0.8 mm) thick.
- E. Flashing Receivers: Fabricate from the following material:
 - 1. Aluminum: 0.0320 inch (0.8 mm) thick.
- F. Roof-Penetration Flashing: Fabricate from the following material:
 - 1. Aluminum-Zinc Alloy-Coated Steel: 0.0276 inch (0.7 mm) thick.

2.6 FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
- C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric or butyl sealant.
- E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 1. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
- F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.

- G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
 - 1. Galvanized or Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.
 - 2. Aluminum: Use aluminum or stainless-steel fasteners.
 - 3. Copper Use copper or stainless-steel fasteners.
 - 4. Stainless Steel: Use stainless-steel fasteners.
- H. Seal joints with elastomeric sealant as required for watertight construction.
- I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm) except where pretinned surface would show in finished Work.
- J. Aluminum Flashing: Rivet or weld joints in uncoated aluminum where necessary for strength.

3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal roof flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces as indicated.
 - 1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 24-inch (600-mm) centers.

3.4 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07620

1.6.5. Section 07841 – Through-Penetration Firestop 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. This Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:
 - 1. Walls and partitions.
- B. Related Sections include the following:
 - 1. Division 15 Sections specifying duct and piping penetrations.
 - 2. Division 16 Sections specifying cable and conduit penetrations.

1.3 PERFORMANCE REQUIREMENTS

- A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.
 - 1. Fire-resistance-rated exterior walls, including partitions, with fire-protection-rated openings.
 - 2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
- B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.

3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.

1.4 SUBMITTALS

- A. Product Data: For each type of through-penetration firestop system product indicated.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.
- C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:
 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - 1) UL in "Fire Resistance Directory."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking

applicable to Project; curing time; and mixing instructions for multi-component materials.

- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

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 (or approved equal):
 - 1. DAP Inc.
 - 2. Hilti Construction Chemicals, Inc.
 - 3. Nelson Firestop Products.
 - 4. RectorSeal Corporation (The).
 - 5. 3M Fire Protection Products.
 - 6. Tremco.
 - 7. United States Gypsum Company.

2.2 FIRESTOPPING, GENERAL

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and

application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

1. Systems exposed to view after completion shall be paintable. Silicone sealants shall not be used where exposed to view.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.3 FILL MATERIALS

- A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

- G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- H. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
- I. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.
- J. Silicone Foams: Multi-component, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- K. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
 - 2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
 - 3. Grade for Vertical Surfaces: Non-sag formulation for openings in vertical and other surfaces.

2.4 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

3.5 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to the alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Firestop Systems for Metallic Pipes, Conduit, or Tubing: Comply with the following:
 1. Available UL-Classified Systems: C-AJ- F-A- W-J- Number Range 1000-1999.
 2. Type of Fill Materials: One or more of the following:
 - a. Latex sealant.
 - b. Silicone sealant.
 - c. Intumescent putty.
 - d. Mortar.
- C. Firestop Systems for Nonmetallic Pipe, Conduit, or Tubing: Comply with the following:
 1. Available UL-Classified Systems: C-AJ- F-A- W-J- Number Range 2000-2999.
 2. Type of Fill Materials: One or more of the following:
 - a. Latex sealant.
 - b. Silicone sealant.
 - c. Intumescent putty.
 - d. Intumescent wrap strips.
 - e. Firestop device.

- D. Firestop Systems for Electrical Cables: Comply with the following:
 - 1. Available UL-Classified Systems: C-AJ- F-A- W-J- Number Range 3000-3999.
 - 2. Type of Fill Materials: One or more of the following:
 - a. Latex sealant.
 - b. Silicone sealant.
 - c. Intumescent putty.
 - d. Silicone foam.
- E. Firestop Systems for Insulated Pipes: Comply with the following:
 - 1. Available UL-Classified Systems: C-AJ- F-A- W-J- Number Range 5000-5999.
 - 2. Type of Fill Materials: One or more of the following:
 - a. Latex sealant.
 - b. Intumescent putty.
 - c. Silicone foam.
 - d. Intumescent wrap strips.
- F. Firestop Systems for Groupings of Penetrations: Comply with the following:
 - 1. Available UL-Classified Systems: C-AJ- F-A- W-J- Number Range 8000-8999.
 - 2. Type of Fill Materials: One or more of the following:
 - a. Latex sealant.
 - b. Mortar.
 - c. Intumescent wrap strips.
 - d. Firestop device.
 - e. Intumescent composite sheet.

END OF SECTION 07841

1.6.6. Section 07901 – Joint Sealants

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes joint sealants for the applications indicated in the joint sealant schedule at the end of Part 3.
- B. Related Sections: The following sections contain information related to this section:
 - 1. Division 8 Section “Glazed Aluminum curtain Walls” for structural glazing sealants.
 - 2. Division 9 Section "Tile" for sealants adjacent to tile.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 1 procedures.
- B. Product Data: Product Data for each specified sealant.
- C. Samples For Initial Selection: Provide samples representing colors selected for products of types indicated.
- D. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an 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 a record of successful in-service performance.

- B. Single Source Responsibility for Joint Sealant Materials: Obtain joint sealant materials from a single manufacturer for each different product required.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
 - 2. When joint substrates are wet.
- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- B. Colors: Provide color of exposed joint sealants to comply with the following:
 - 1. Provide selections made by Supervising Professional from manufacturer's colors indicated in joint sealant schedule for products of type indicated.

2.2 CHEMICALLY CURING ELASTOMERIC JOINT SEALANTS

- A. Multicomponent Nonsag Urethane Sealant ES-1.
 - 1. Available Products:
 - a. Sonneborn, Division of Chemrex Inc.; NP-2.
 - b. Tremco equivalent
 - a. Sealtex equivalent
 - b. Or approved equal
 - 2. Type and Grade: M (Multi-component) and NS (Non Sag).
 - 3. Class 25.
 - 4. Uses Related to Exposure: NT (Non Traffic).
 - 5. Uses Related to Joint Substrates: M, G, A, and O.
- B. Multicomponent, gun grade, polyurethane sealant ES-2.
 - 1. Available Products:
 - a. Tremco THC-901.
 - b. Sonneborn equivalent
 - c. Sealtex equivalent
 - d. Or approved equal
 - 2. Type and Grade: M (Multi-component) Grade P.
 - 3. Class 25.
 - 4. Use Related to Exposure: T (Traffic).
 - 5. Use Related to Joint Substrates: M, and O
- C. Multi-component, gun grade, polyurethane sealant ES-3.
 - 1. Available Products:
 - a. Sonneborn, Division of Chemrex, Inc.; SL2.
 - b. Tremco equivalent
 - c. Sealtex equivalent
 - d. Or approved equal
 - 2. Type and Grade: M (Multi-component); Grade P.
 - 3. Class 25.
 - 4. Use Related to Exposure: T (Traffic).
 - 5. Use Related to Joint Substrate: M and O.

2.3 LATEX JOINT SEALANTS

- A. General: Provide manufacturer's standard one-part, nonsag, mildew-resistant, paintable latex sealant of formulation indicated that is recommended for exposed applications on interior and protected exterior locations and that accommodates indicated percentage change in joint width existing at time of installation without failing either adhesively or cohesively.
- B. Acrylic-Emulsion Sealant: Provide product complying with ASTM C 834 that accommodates joint movement of not more than 5 percent in both extension and compression for a total of 10 percent.

- C. Latex Sealant LS-1
 - 1. Available Products:
 - a. Tremco; Tremflex 834
 - b. Sonolac, Sonneborn, Division of Chemrex, Inc.
 - c. Sealtex equivalent
 - d. Or approved equal
 - 2. Type and Grade: Type P; Grade NF.
 - 3. Class 12.5.
 - 4. Use Related to Exposure: NT.
 - 5. Use Related to Joint Substrate: O.

2.4 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Plastic Foam Joint Fillers: Preformed, compressible, resilient, non-staining, non-waxing, non-extruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - 1. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, non-outgassing in unruptured state.

2.5 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and

other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean concrete, masonry, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 - 3. Remove laitance and form release agents from concrete.
 - 4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealant manufacturer. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

- C. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
 - 1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - a. Do not leave gaps between ends of joint fillers.
 - b. Do not stretch, twist, puncture, or tear joint fillers.
 - c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.
- E. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
- F. All joint sealants used on fire rated wall assemblies (3-hour occupancy separation) shall be U.L. listed materials suitable for use in a tested and listed assembly.

3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved 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 or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

3.6 JOINT SEALANT SCHEDULE

- A. Joint Sealant Application JS-1, exterior vertical construction joints.
 - 1. Joint Sealant: ES-1.
 - 2. Joint Sealant Color: Match adjacent material color.

- B. Joint Sealant Application JS-2, exterior horizontal traffic joints in cast-in-place concrete slabs.
 - 1. Joint Sealant: ES-2.
 - 2. Joint Sealant Color: Match color of concrete.
- C. Joint Sealant Application JS-4, exterior perimeter joints at frames of doors, windows, and louvers.
 - 1. Joint Sealant: ES-1.
 - 2. Joint Color: Match adjacent frame color.
- D. Joint Sealant Application JS-5, interior vertical joints.
 - 1. Joint Sealant: LS-1.
 - 2. Joint Color: Match adjacent material color.
- E. Joint Sealant Application JS-6, interior perimeter joints at frames of doors, windows, and louvers.
 - 1. Joint Sealant: LS-1.
 - 2. Joint Color: Match adjacent frame color.
- F. Joint Sealant Application JS-7, interior expansion, control, contraction, and isolation joints in horizontal traffic tile surfaces.
 - 1. Joint Sealant: ES-3.
 - 2. Joint Sealant Color: Match grout color.
- G. Joint Sealant Application JS-8, interior joints between plumbing fixtures and adjoining walls, floors, and counters.
 - 1. Joint Sealant: LS-1.
 - 2. Joint Sealant Color: Match adjacent material color.

END OF SECTION 07901

1.7. Division 8 – Doors & Windows

1.7.1. Section 08110 – Hollow Metal Doors And Frames

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes hollow metal doors and frames.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 4 Section "Unit Masonry" for building anchors into and grouting frames in masonry construction.
 - 2. Division 8 Section "Door Hardware" for door hardware and weatherstripping.
 - 3. Division 9 Section "Painting" for field finishing primed doors and frames.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Shop Drawings showing fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.
- C. Door Schedule: Submit schedule of doors and frames using same reference numbers for details and openings as those on Contract Drawings.
 - 1. Indicate coordination of glazing frames and stops with glass and glazing requirements.

1.4 QUALITY ASSURANCE

- A. Provide doors and frames complying with ANSI/SDI 100 "Recommended Specifications for Standard Steel Doors and Frames" and as specified.

- B. Fire-Rated Door Assemblies: Units that comply with NFPA 80, are identical to door and frame assemblies tested for fire-test-response characteristics per ASTM E 152, and are labeled and listed by U.L., Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard-wrapped or crated to provide protection transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
- B. Inspect doors and frames on delivery for damage. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect; otherwise, remove and replace damaged items as directed.
- C. Store doors and frames at building site under cover. Place units on minimum 4-inch- (100-mm-) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch (6-mm) spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following (or approved equal):
 - 1. Steel Doors and Frames:
 - a. Amweld Building Products, Inc.
 - b. Benchmark Commercial Doors.
 - c. Ceco Door Products.
 - d. Copco Door Co.
 - e. Curries Co.
 - f. Deansteel Manufacturing Co.
 - g. Fenestra Corp.
 - h. Kewanee Corp.
 - i. Mesker Door, Inc.
 - j. Pioneer Industries.
 - k. Republic Builders Products.
 - l. Steelcraft.

2.2 MATERIALS

- A. Hot-Rolled Steel Sheets and Strip: Commercial-quality carbon steel, pickled and oiled, complying with ASTM A 569 (ASTM A 569M).

- B. Cold-Rolled Steel Sheets: Carbon steel complying with ASTM A 366 (ASTM A 366M), commercial quality, or ASTM A 620 (ASTM A 620M), drawing quality, special killed.
- C. Galvanized Steel Sheets: Zinc-coated carbon steel complying with ASTM A 526 (ASTM A 526M), commercial quality, or ASTM A 642 (ASTM A 642M), drawing quality, hot-dip galvanized according to ASTM A 525, with A 60 or G 60 (ASTM A 525M, with Z 180 or ZF 180) coating designation, mill phosphatized.
- D. Supports and Anchors: Fabricated from not less than 0.0478-inch- (1.2-mm-) thick steel sheet; 0.0516-inch- (1.3-mm-) thick galvanized steel where used with galvanized steel frames.
- E. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize complying with ASTM A 153, Class C or D as applicable.

2.3 DOORS

- A. Steel Doors: Provide 1-3/4-inch- (44-mm-) thick doors of materials and ANSI/SDI 100 grades and models indicated on Drawings or schedules.
 - 1. Exterior Doors: Grade II, heavy-duty, designs with glazing as shown, minimum 0.0516-inch- (1.3-mm-) thick galvanized steel sheet faces.
 - 2. Interior Doors: Grade II, heavy-duty, full flush design or designs with glazing as shown, minimum 0.0478-inch- (1.2-mm-) thick cold-rolled steel sheet faces.

2.4 FRAMES

- A. Provide metal frames for doors, transoms, sidelights, borrowed lights, and other openings, according to ANSI/SDI 100, and of types and styles as shown on Drawings and schedules. Conceal fastenings, unless otherwise indicated. Fabricate frames of minimum 0.0478-inch- (1.2-mm-) thick cold-rolled steel sheet.
 - 1. Fabricate frames with mitered or coped and continuously welded corners.
 - 2. Fabricate frames for interior openings over 48 inches (1220 mm) wide from 0.0598-inch- (1.5-mm-) thick steel sheet.
 - 3. Form exterior frames from 14 gage galvanized steel.
- B. Door Silencers: Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single-door frames and 2 silencers on heads of double-door frames.

- C. Plaster Guards: Provide minimum 0.0179-inch- (0.45-mm-) thick steel plaster guards or mortar boxes at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.
- D. Grout: When required in masonry construction, as specified in Division 4 Section "Unit Masonry."

2.5 FABRICATION

- A. Fabricate steel door and frame units to be rigid, neat in appearance, and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site. Comply with ANSI/SDI 100 requirements.
 - 1. Internal Construction: One of the following manufacturer's standard core materials according to SDI standards:
 - a. Resin-impregnated paper honeycomb, Rigid polyurethane conforming to ASTM C 591, Rigid polystyrene conforming to ASTM C 578, Unitized steel grid, or Vertical steel stiffeners.
 - b. Rigid mineral fiber with internal sound deadener on inside of face sheets where appropriate in accordance with SDI standards.
 - 2. Clearances: Not more than 1/8 inch (3.2 mm) at jambs and heads, except not more than 1/4 inch (6.4 mm) between non-fire-rated pairs of doors. Not more than 3/4 inch (19 mm) at bottom.
 - a. Fire Doors: Provide clearances according to NFPA 80.
- B. Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel sheet.
- C. Tolerances: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.
- E. Galvanized Steel Doors, Panels, and Frames: For the following locations, fabricate doors, panels, and frames from galvanized steel sheet according to SDI 112. Close top and bottom edges of doors flush as an integral part of door construction or by addition of minimum 0.0635-inch- (1.6-mm-) thick galvanized steel channels, with channel webs placed even with top and bottom edges. Seal joints in top edges of doors against water penetration.
 - 1. At exterior locations and where indicated on door schedule.
- F. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

- G. Thermal-Rated (Insulating) Assemblies: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal-insulating door and frame assemblies and tested according to ASTM C 236 or ASTM C 976 on fully operable door assemblies.
 - 1. Unless otherwise indicated, provide thermal-rated assemblies with U-value rating of 0.41 Btu/sq. ft. x h x deg F (2.33 W/sq. m x K) or better.
- H. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of SDI 107 and ANSI A115 Series specifications for door and frame preparation for hardware.
- I. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.
- J. Locate hardware as indicated on Shop Drawings or, if not indicated, according to the Door and Hardware Institute's (DHI) "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2.6 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual" for recommendations relative to applying and designating finishes.
- B. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for steel sheet finishes.
- C. Apply primers and organic finishes to doors and frames after fabrication.

2.7 GALVANIZED STEEL SHEET FINISHES

- A. Surface Preparation: Clean surfaces with nonpetroleum solvent so that surfaces are free of oil or other contaminants. After cleaning, apply a conversion coating of the type suited to the organic coating applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
 - 1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.
- B. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply air-dried primer specified below immediately after cleaning and pretreatment.
 - 1. Shop Primer: Zinc-dust, zinc-oxide primer paint complying with performance requirements of FS TT-P-641, Type II.

2.8 STEEL SHEET FINISHES

- A. Surface Preparation: Solvent-clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel to comply with SSPC-SP 5 (White Metal Blast Cleaning) or SSPC-SP 8 (Pickling).
- B. Pretreatment: Immediately after surface preparation, apply a conversion coating of type suited to organic coating applied over it.
- C. Factory Priming for Field-Painted Finish: Apply shop primer that complies with ANSI A224.1 acceptance criteria, is compatible with finish paint systems indicated, and has capability to provide a sound foundation for field-applied topcoats. Apply primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.
- B. Placing Frames: Comply with provisions of SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 - 1. Except for frames located in existing concrete, masonry, or gypsum board assembly construction, place frames before constructing enclosing walls and ceilings.
 - 2. In masonry construction, install at least 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
 - 3. Install fire-rated frames according to NFPA 80.
- C. Door Installation: Fit hollow-metal doors accurately in frames, within clearances specified in ANSI/SDI 100.
 - 1. Fire-Rated Doors: Install with clearances specified in NFPA 80.

3.2 ADJUSTING AND CLEANING

- A. Prime Coat Touchup: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

- B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION 08110

1.7.2. Section 08112 – Aluminum Frames

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior aluminum frames for doors.
- B. Related Sections include the following:
 - 1. Division 06 Section "Miscellaneous Carpentry" for carpentry for wood framing and blocking.
 - 2. Division 07 Section "Joint Sealants" for joint sealants installed with interior aluminum frames and for sealants to the extent not specified in this Section.
 - 3. Division 08 Section "Flush Wood Doors" for wood doors installed in interior aluminum frames.
 - 4. Division 08 Section "Door Hardware" for door hardware.
 - 5. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for partitions.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of interior aluminum frame indicated.
- B. Shop Drawings: For interior aluminum frames. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: 12-inch- (300-mm) long framing member with factory-applied finish for each type of interior aluminum frame indicated.
- E. Fabrication Sample: For each vertical-to-horizontal intersection of systems, made from 12-inch (300-mm) lengths of full-size components and showing details of assembly.

- F. Maintenance Data: For interior aluminum frames to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers. Subject to compliance with requirements, products that may be incorporated into the work include:
 - 1. Custom Components Company.
 - 2. Dual Lock Partition Systems, Inc.
 - 3. Frameworks Manufacturing.
 - 4. Modulex, Inc.
 - 5. RACO Interior Products, Inc.
 - 6. Versatrac.
 - 7. Western Integrated Materials, Inc.
 - 8. Wilson Partitions.

2.2 COMPONENTS

- A. Aluminum Framing, General: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or alloy and temper required to suit structural and finish requirements, not less than 0.062 inch (1.6 mm) thick.
- B. Door Frames: Reinforced for hinges and strikes.
- C. Trim: Extruded aluminum, not less than 0.062 inch (1.6 mm) thick, with removable snap-in casing trim and door stops without exposed fasteners.

2.3 ACCESSORIES

- A. Fasteners: Aluminum, nonmagnetic stainless-steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. Sound Seals: Manufacturer's standard continuous mohair, wool pile, or vinyl seals.
- C. Hardware: Comply with requirements in Division 08 door hardware Sections.

2.4 FABRICATION

- A. Machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required, and fastened within frame with concealed screws.

- B. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted or mitered connections.
- C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
- D. Fabricate all components to allow secure installation without exposed fasteners.

2.5 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and ceilings, with Installer present, for conditions affecting performance of work.
 - 1. Verify that wall thickness does not exceed standard tolerances allowed by throat size indicated. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with frame manufacturer's written installation instructions.
- B. Install frames plumb and square, securely anchored to substrates.
- C. Install frame components in the longest possible lengths; components up to 96 inches long must be ONE piece.
 - 1. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
 - 2. Secure clips to main structural extrusion components and not to snap-in or trim members.
 - 3. Do not leave screws or other fasteners exposed to view when installation is complete.

3.3 CLEANING

- A. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended by frame manufacturer and according to AAMA 609 & 610.
- B. Touch up marred frame surfaces so touchup is not visible from a distance of 48 inches (1220 mm). Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION 08112

1.7.3. Section 08211 – Flush Wood Doors

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Fitting wood doors to frames and machining for hardware.
- B. Related Sections include the following:
 - 1. Division 8 Section "Glazing" for glass view panels in flush wood doors.
 - 2. Division 8 Section "Door Hardware".

1.3 SUBMITTALS

- A. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and other pertinent data.
 - 1. Indicate dimensions and locations of cutouts.
 - 2. Indicate fire ratings for fire doors.
- B. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.
- B. Quality Standard: Comply with the following standard:
 - 1. AWI Quality Standard: AWI's "Architectural Woodwork Quality Standards" for grade of door, core, construction, finish, and other requirements.
- C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Mark each door with individual opening numbers used on Shop Drawings. Use removable tags or concealed markings.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of the construction period to comply with requirements of the referenced quality standard for Project's geographical location.

1.7 WARRANTY

- A. General Warranty: Door manufacturer's warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Door Manufacturer's Warranty: Submit written agreement on door manufacturer's standard form, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 1/4 inch (6.35 mm) in a 42-by-84-inch (1067-by-2134-mm) section or that show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 75-mm) span, or do not comply with tolerances in referenced quality standard.
 - 1. Warranty shall be in effect during the following period of time after the date of Substantial Completion:
 - a. Solid-Core Interior Doors: Life of installation.

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 (or approved equal):
 - 1. Flush Wood Doors:
 - a. Algoma Hardwoods Inc.
 - b. Ampco Products, Inc.

- c. Buell Door Co.
- d. Chappell Door Co.
- e. Eagle Plywood & Door Manufacturing, Inc.
- f. Eggers Industries; Architectural Door Division.
- g. Graham Manufacturing Corp.
- h. Haley Brothers, Inc.
- i. Ideal Wood Products, Inc.
- j. IPIK Door Co., Inc.
- k. Marlite.
- l. Mohawk Flush Doors, Inc.
- m. Oshkosh Architectural Door Co.
- n. Poncraft Door Co.
- o. Vancouver Door Company, Inc.
- p. V-T Industries Inc.
- q. Weyerhaeuser Co.

2.2 DOOR CONSTRUCTION, GENERAL

- A. Doors for Transparent Finish: Comply with the following requirements:
 - 1. Grade: Premium (Grade A faces).
 - 2. Faces: Red oak, plain sliced.
 - 3. Match between Veneer Leaves: Book match.
 - 4. Match within Door Faces: Running match.
 - 5. Pair and Set Match: Provide for pairs of doors and for doors hung in adjacent sets.

2.3 SOLID-CORE DOORS

- A. Interior Veneer-Faced Doors: Comply with the following requirements:
 - 1. Core: Glued-block core.
 - 2. Construction: Five plies with stiles and rails bonded to core, then entire unit abrasive planed before veneering.
- B. Fire-Rated Doors: Comply with the following requirements:
 - 1. Construction: Construction and core specified above for type of face indicated or manufacturer's standard mineral-core construction as required to provide fire rating indicated.
 - 2. Blocking: For mineral-core doors, provide composite blocking with improved screw-holding capability approved for use in doors of fire ratings indicated and as follows:
 - a. As necessary to eliminate need for through-bolting hardware.

2.4 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:

1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements of NFPA 80 for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- C. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.
 1. Louver Openings: Trim openings with moldings of material and profile indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine installed door frames before hanging doors.
 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.
 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Division 8 Section "Door Hardware."
- B. Manufacturer's Written Instructions: Install wood doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Field-Finished Doors: Refer to the following for finishing requirements:
 1. Division 9 Section "Painting."

3.3 ADJUSTING AND PROTECTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Refinish or replace doors damaged during installation.

- C. Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 08211

1.7.4. Section 08311 – Access Doors and Frames

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Wall access doors and frames.
 - 2. Ceiling access doors and frames.
- B. Related Sections include the following:
 - 1. Division 4 Section "Unit Masonry Assemblies" for anchoring and grouting access door frames set in masonry construction.

1.3 SUBMITTALS

- A. Product Data: For each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain doors and frames through one source from a single manufacturer.
- B. Size Variations: Obtain Supervising Professional's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.5 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in "Submittals" Article.

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 (or approved equal):
 - 1. Access Doors:
 - a. Acudor Products, Inc.
 - b. Cesco Products.
 - c. Jensen Industries.
 - d. J. L. Industries, Inc.
 - e. Larsen's Manufacturing Company.
 - f. MIFAB Manufacturing, Inc.
 - g. Precision Plumbing Products, Inc.

2.2 PAINT

- A. Shop Primers: Provide primers that comply with Division 9 Section "Painting."
- B. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- C. Shop Primer for Metallic-Coated Steel: Organic zinc-rich primer complying with SSPC-Paint 20 and compatible with topcoat.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

2.3 ACCESS DOORS AND FRAMES

- A. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.
 - 1. Locations: wall and ceiling surfaces.
 - 2. Door: Minimum 0.060-inch- (1.5-mm-) thick sheet metal, set flush with exposed face flange of frame.
 - 3. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with 1-inch- (25-mm-) wide, surface-mounted trim.
 - 4. Hinges: Continuous piano hinge.
 - 5. Latch: Screwdriver- operated cam latch.

2.4 FABRICATION

- A. General: Provide access door assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Steel Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

2.5 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- C. Color: Paint access panels exposed to view to match adjacent surfaces. Where differing surfaces are adjacent, consult with the Supervising Professional.

2.6 STEEL FINISHES

- A. Surface Preparation: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- B. Apply shop primer to uncoated surfaces of metal fabrications. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Advise installers of other work about specific requirements relating to access door and floor door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.

3.3 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08311

1.7.5. Section 08710 – Door Hardware

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.
- B. The intention of this section is to call for a complete line of finish hardware for all doors. Any item of finish hardware not specifically mentioned hereinafter but necessary to fulfill this intention and the proper completion of this Project shall be provided. The cost of such items shall be part of the Contract Sum. Where size, shape, or operation of members is such as to prevent the use of type specified, suitable types of hardware shall be furnished that have the same operation and quality as the type specified and of sizes adequate for the service intended.
- C. This Section includes the following:
 - 1. Hinges.
 - 2. Lock cylinders and keys.
 - 3. Lock and latch sets.
 - 4. Bolts.
 - 5. Closers.
 - 6. Miscellaneous door control devices and accessories.
 - 7. Thresholds.
 - 8. Programmable Locks.
- D. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 8 Section "Steel Doors and Frames" for silencers integral with hollow metal frames.
 - 2. Division 8 Section "Aluminum Frames"
 - 3. Division 8 Section "Flush Wood Doors" for factory pre-fitting and factory pre-matching of doors for door hardware.
 - 4. Division 8 Section "Aluminum Entrances and Store Fronts" for hardware associated with Aluminum Entrances and Storefronts.
 - 5. Division 16 Sections for wiring of specified hardware electronics.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1. Specification sections.
- B. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
 - a. Type, style, function, size, and finish of each hardware item.
 - b. Name and manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of each hardware set cross referenced to indications on drawings both on floor plans and in door and frame schedule.
 - e. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for hardware.
 - g. Door and frame sizes and materials.
 - h. Keying information.
 - i. Wiring diagrams for programmable locks.
 - 2. Submittal Sequence: Submit initial draft of final schedule along with essential product data in order to facilitate the fabrication of other work that is critical in the Project construction schedule. Submit final schedule after samples, product data, coordination with shop drawings of other work, delivery schedules, and similar information has been completed and accepted.
 - 3. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.
- C. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- D. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware. This shall be included in Operating and Maintenance Manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain each type of hardware (latch and lock sets, hinges, closers, etc.) from a single manufacturer.

- B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant who is available to Owner, Supervising Professional, and Contractor, at reasonable times during the course of the Work, for consultation.
 - 1. Require supplier to meet with Owner to finalize keying requirements and to obtain final instructions in writing.
- C. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels.
- D. Provide 5-year manufacturer warranty for door closers.

1.5 PRODUCT HANDLING

- A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.
- B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.
- C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
- D. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).
- E. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Manufacturers providing products that may be incorporated into the work include, but are not limited to, the following (or approved equal):
1. Butts and Hinges:
 - a. Hager Hinge Co.
 - b. Lawrence Brothers, Inc.
 - c. McKinney Products Co.
 2. Cylinders and Locks:
 - a. D-Series, Schlage Lock, Div. Ingersoll-Rand Door Hardware Group.
 - b. 10-Line, Sargent
 - c. Best H Series
 3. Latch Guard:
 - a. Hagar
 - b. Sargent
 - c. Schlage
 4. Push/Pull Units:
 - a. Brookline Industries, Div. Yale Security Inc.
 - b. Corbin & Russwin Architectural Hardware, Div. Black & Decker Corp.
 - c. Hager Hinge Co.
 5. Overhead Closers:
 - a. LCN, Div. Ingersoll-Rand Door Hardware Group.
 - b. Norton Door Controls, Div. Yale Security Inc.
 - c. Sargent Manufacturing Company.
 6. Door Stops:
 - a. Brookline Industries, Div. Yale Security Inc.
 - b. Hager Hinge Co.
 - c. Sargent
 7. Kick, Mop, and Armor Plates:
 - a. Brookline Industries, Div. Yale Security Inc.
 - b. Hager Hinge Co.
 - c. Rockwood
 8. Door Weatherstripping:
 - a. Hager Hinge Co.
 - b. National Guard Products, Inc.
 - c. Reese Enterprises, Inc.
 9. Thresholds:
 - a. Hager Hinge Co.
 - b. National Guard Products, Inc.
 - c. Reese Enterprises, Inc.
 10. Coordinator:
 - a. Glynn-Johnson
 - b. Sargent

- c. Schlage
- 11. Automatic Flush Bolts/Dust Proof Strike
 - a. Glynn-Johnson
 - b. Sargent
 - c. Schlage

2.2 SCHEDULED HARDWARE

- A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in Part 3 of this Section. Products are identified by using hardware designation numbers of the following:
 - 1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, a comparable product by another manufacturer. Substitution products are not accepted until approved shop drawings are returned to the Contractor.

2.3 MATERIALS AND FABRICATION

- A. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.
- B. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.
- C. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
- D. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use six screw fasteners.

2.4 HINGES, BUTTS, AND PIVOTS

- A. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- B. Screws: Provide Phillips flat-head screws complying with the following requirements:
 - 1. For metal doors and frames install machine screws into drilled and tapped holes.
 - 2. For wood doors and frames install wood screws.
 - 3. For fire-rated wood doors install #12 x 1-1/4-inch, threaded-to-the-head steel wood screws.
 - 4. Finish screw heads to match surface of hinges or pivots.
- C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - 1. Out-Swing Exterior Doors: Non-removable pins.
 - 2. Out-Swing Corridor Doors with Locks: Non-removable pins.
 - 3. Interior Doors: Non-rising pins.
 - 4. Tips: Flat button and matching plug, finished to match leaves.
- D. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges per door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height.
 - 1. Fire-Rated Doors: Not less than 3 hinges per door leaf for doors 86 inches or less in height with same rule for additional hinges.

2.5 LOCK CYLINDERS AND KEYING

- A. Review the keying system with the Owner and provide the type required (master, grandmaster or great-grandmaster), either new or integrated with Owner's existing system.
- B. Equip locks with manufacturer's standard 6-pin tumbler cylinders.
- C. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.
- D. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks.
 - 1. Permanently inscribe each key with number of lock that identifies cylinder manufacturer's key symbol, and notation, "DO NOT DUPLICATE."
- E. Key Material: Provide keys of nickel silver only.

- F. Key Quantity: Furnish 10 master keys for each master system, 2 grandmaster keys for each grandmaster system and 6 construction keys.
 - 1. Deliver keys to Owner.
- G. Key Cabinet: Provide adequate sized key cabinet for keys and locate as directed by owner.

2.6 LOCKS, LATCHES, AND BOLTS

- A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.
 - 1. Provide recess type top strikes for bolts locking into head frames, unless otherwise indicated.
 - 2. Provide dust-proof strikes for foot bolts, except where special threshold construction provides non-recessed strike for bolt.
 - 3. Provide roller type strikes where recommended by manufacturer of the latch and lock units.
- B. Lock Throw: Provide 5/8-inch minimum throw of latch on pairs of doors. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.
 - 1. Provide ½-inch minimum throw of latch for other bored and pre-assembled types of locks and 3/4-inch minimum throw of latch for mortise locks. Provide 1-inch minimum throw for all dead bolts.
- C. Handle Design: Provide locksets with Schlage Sparta design lever handles.
- D. Flush Bolt Heads: Minimum of ½-inch-diameter rods of stainless steel with minimum 12-inch-long rod for doors up to 7'-0" in height. Provide longer rods as necessary for doors exceeding 7'-0" in height.
- E. Programmable locks: Provide low voltage wiring from transformer to door controller at programmable locks. Coordinate interface with electrical contractor.

2.7 CLOSERS AND HANDLES

- A. Size of Units: Except as otherwise specifically indicated, comply with the manufacturer's recommendations for size of door control unit depending on size of door, exposure to weather, and anticipated frequency of use.
 - 1. Where parallel arms are indicated for closers, provide closer unit one size larger than recommended for use with standard arms.
 - 2. Provide parallel arms for all overhead closers, except as otherwise indicated.

- B. Barrier-Free Manual Closers: Where manual closers are indicated for doors required to be accessible to the physically handicapped, provide adjustable units complying with ADAAG provisions for door opening force and delayed action closing.
- C. Provide grey resilient parts for exposed bumpers.

2.8 WEATHERSTRIPPING AND SEALS

- A. General: Provide continuous weatherstripping on exterior doors and smoke, light, or sound seals on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated.
- B. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.
- C. Weatherstripping at Jambs and Heads: Provide bumper-type resilient insert and metal retainer strips, surface applied unless shown as mortised or semimortised, and of following metal, finish, and resilient bumper material:
 - 1. Extruded aluminum with natural anodized finish, 0.062-inch minimum thickness of main walls and flanges.

2.9 THRESHOLDS

- A. General: Except as otherwise indicated, provide standard metal threshold unit of type, size, and profile as shown or scheduled.
- B. Exterior Hinged or Pivoted Doors: Provide units not less than 4 inches wide, formed to accommodate change in floor elevation where indicated, fabricated to accommodate door hardware.

2.10 HARDWARE FINISHES

- A. Standard finish for all hardware items is BHMA 630/US 32D, satin stainless steel, except as otherwise indicated.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- C. Provide protective lacquer coating on all exposed hardware finishes of brass, bronze, and aluminum, except as otherwise indicated. The suffix "-NL" is used with standard finish designations to indicate "no lacquer."

1. Rust-Resistant Finish: For iron and steel base metal required for exterior work and in areas shown as "High Humidity" areas (and also when designed with the suffix -RR), provide 0.2-mil-thick copper coating on base metal before applying brass, bronze, nickel, or chromium plated finishes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Supervising Professional.
 1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
 2. NWWDA Industry Standard I.S.1.7, "Hardware Locations for Wood Flush Doors."
- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
- C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 7 Section "Joint Sealers."
- F. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.2 ADJUSTING, CLEANING, AND DEMONSTRATING

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
 1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week

prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

- B. Clean adjacent surfaces soiled by hardware installation.
- C. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.
- D. Six-Month Adjustment: Approximately six months after the date of Substantial Completion, the Installer shall contact the Owner's representative and Supervising Professional to schedule an on-site adjustment of the hardware. The Installer, accompanied by the necessary representatives of the manufacturers of major hardware suppliers, shall return to the Project to perform the following work:
 - 1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
 - 2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
 - 3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
 - 4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.3 HARDWARE SCHEDULE

- A. General: Provide hardware for each door to comply with requirements of this section, hardware set numbers indicated in door schedule, and in the following schedule of hardware sets.
 - 1. Hardware sets indicate quantity, item, manufacturer and product designation, size, and finish or color, as applicable. Items of other manufacturers as listed in PART 2 – PRODUCTS, may be substituted for scheduled items.

HARDWARE SETS

<u>HARDWARE SET 1</u>				
<u>Quantity</u>	<u>Item</u>	<u>Manufacturer</u>	<u>Product</u>	<u>Finish</u>
Refer to Division 8 Specifications "Glazed Aluminum Curtain Walls."				

<u>HARDWARE SET 1a</u> (Wide Entrance with weather strip)				
<u>Quantity</u>	<u>Item</u>	<u>Manufacturer</u>	<u>Product</u>	<u>Finish</u>
4	Hinges	Hager	BB1279 (6" high)	US32D
1	Programmable Entrance	Schlage/ Locknetics	PRO5196-FSE Hardwired 24 Volt. Coordinate With Electrical.	626
1	Closer with stop feature	LCN	4111-H Cush	AL
1	Threshold	Reese	S205A* (ADA compliant, 5 inch wide)	AL
1	Weatherstripping	Reese	757C	Black
1	Sweep	Reese	323C	AL
1	Kickplate	Hager	190S 10" (exterior only)	US32D
1	Latchguard	Hager	340D	US32D
*S483AN Fire Rated Threshold at door 103.				
<u>HARDWARE SET 1b</u>				
<u>Quantity</u>	<u>Item</u>	<u>Manufacturer</u>	<u>Product</u>	<u>Finish</u>
3	Hinges	Hager	BB1279 (4.5" x 4.5")	US32D
1	Lockset - Entrance	Sargent	10-F82-LJ	US32D
1	Closer with stop feature	LCN	4111-H Cush	AL
1	Kickplate	Hager	190S 10" (one side only)	US32D
<u>HARDWARE SET 1c</u>				
<u>Quantity</u>	<u>Item</u>	<u>Manufacturer</u>	<u>Product</u>	<u>Finish</u>
3	Hinges	Hager	BB1279 (4.5" x 4.5")	US32D
1	Lockset - Entrance	Sargent	10-F82-LJ	US32D
1	Closer with stop feature	LCN	4111-H Cush	AL
1	Threshold	Reese	S205A* (ADA compliant, 5 inch wide)	AL
1	Weatherstripping	Reese	757C	Black
1	Sweep	Reese	323C	AL
1	Kickplate	Hager	190S 10" (exterior only)	US32D
1	Latchguard	Hager	340D	US32D
<u>HARDWARE SET 1d</u>				
<u>Quantity</u>	<u>Item</u>	<u>Manufacturer</u>	<u>Product</u>	<u>Finish</u>
2	Hinges – Spring Hinge	Hager	BB1250 (3.5" x 3.5")	US32D
1	Lockset - Entrance	Sargent	10-F82-LJ*	US32D
* Coordinate lockset installation with custom door handle guard.				
<u>HARDWARE SET 2</u>				
<u>Quantity</u>	<u>Item</u>	<u>Manufacturer</u>	<u>Product</u>	<u>Finish</u>
3	Hinges	Hager	BB1191	US32D
1	Lockset - Passage	Sargent	10-F75-LJ	US32D
1	Closer with stop feature	LCN	4111-H Cush	AL
2	Kickplate	Hager	190S 10" (both sides of door)	US32D

<u>HARDWARE SET 3</u>				
<u>Quantity</u>	<u>Item</u>	<u>Manufacturer</u>	<u>Product</u>	<u>Finish</u>
3	Hinges	Hager	BB1191	US32D
1	Bath Privacy	Sargent	10-F76-LJ	US32D
1	Closer with stop feature	LCN	4111-H	AL
2	Kickplate	Hager	190S 10" (both sides of door)	US32D

END OF SECTION 08710

1.7.6. Section 08810 – Glazing

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 glazing for the following field-glazed installations:
 - 1. Glazed Aluminum Curtain Walls (including doors and windows)
 - a. Ceramic frit coatings.
 - b. Laminated glass.
 - 2. Interior Windows
 - 3. Interior doors.

1.3 RELATED SECTIONS

- A. Factory pre-glazed products shall comply with requirements identified in their respective sections.
 - 1. Division 8 Section "Flush Wood Doors".
 - 2. Division 8 Section "Steel Doors and Frames".
 - 3. Division 8 Section "Aluminum Frames".

1.4 DEFINITIONS

- A. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.5 SUBMITTALS

- A. General: submit the following in accordance with Division 1 requirements.
- B. Samples for initial selection and final verification. Provide minimum 12 in. x 12 in. actual samples of each glass type specified.
- C. Shop Drawings: Indicating location of each glass type.

- D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
- E. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glazing materials and glazing channel substrates and for compatibility with glazing materials.
- F. Warranties: Special warranties specified in this Section.
- G. Maintenance data for glass and other glazing materials to include in Operating and Maintenance Manual specified in Division 1.

1.6 QUALITY ASSURANCE

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. FGMA Publications: "FGMA Glazing Manual."
 - 2. SIGMA Publications: TM-3000 "Vertical Glazing Guidelines" and TB-3001 "Sloped Glazing Guidelines."
- B. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.
 - 1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.
- C. Insulating Glass Certification Program: Provide insulating glass units permanently marked either on spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency indicated below:
 - 1. Insulating Glass Certification Council (IGCC).
- D. GANA Publications: GANA'S "Glazing Manual" and "Laminated Glass Design Guide." Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in-service performance.
- E. Single-Source Responsibility for Glass: Obtain glass from one source for each product indicated below:
 - 1. Primary glass of each (ASTM C 1036) type and class indicated.
 - 2. Heat-treated glass of each (ASTM C 1048) condition indicated.
 - 3. Insulating glass of each construction indicated.
 - 4. Laminated glass of each condition indicated.

- F. Single-Source Responsibility for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver glass products to the project site until they can be incorporated in the work in a timely manner. Glass that can not be installed immediately shall be carefully stored and protected from damage due to construction operations.
- B. Glass products shall be handled with great care to prevent damage. Utilize tools, equipment, vehicle, etc. specifically designed to handle glass products in a safe and secure manner.
- C. Inspect glass immediately prior to installation to check for any damage to the material which would detract from its perfect appearance or performance. Replace damaged glass.

1.7 PROJECT CONDITIONS

- A. Assure environmental conditions comply with glazing manufacturer's requirements before installing.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form, made out to Owner and signed by manufacturer, in which manufacturer agrees to furnish replacements for units that deteriorate from normal use by developing defects attributable to the manufacturing process, f.o.b. the nearest shipping point to Project site, within warranty period.
 - 1. Laminated Glass: Form of Deterioration: Edge separation or delamination that materially obstructs vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - a. Warranty Period: Five years from date of Substantial Completion.
- B. Insulating Glass:
 - a. Warranty Period: Ten years from date of Substantial Completion.
- C. Ceramic Frit coated glass:
 - a. Warranty Period: Five years from date of substantial completion.

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. Basis-of-Design Product: The design for each glazing product is based on the products listed. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following:
 - a. Cardinal IG
 - b. Oldcastle Glass Group
 - c. Pilkington Building Products North America
 - d. PPG Industries, Inc.

2.2 GLASS TYPE 1 – SEALED INSULATING GLASS UNITS (GL-1)

- A. Glazing located in exteriorcurtain walls, windows, doors. Specific coating types indicated in this Article.
- B. Sealed Insulating Glass Units: Preassembled units consisting of organically sealed lites of glass separated by dehydrated air spaces complying with ASTM E 774 and with other requirements as indicated on the drawings.
 - 1. Clerestory Glazing “GL1-A”: Insulating Glass Unit Makeup:
 - a. Basis-of-Design Product: Viracon VE3-55.
 - b. Overall Unit Thickness: 1-inch.
 - c. Outboard Lite: ¼” grey, tempered, VE-355 coating on #2 surface.
 - d. Spacer: ½-inch.
 - e. Gas Fill: Air.
 - f. Inboard Lite: ¼” clear , tempered.
 - g. SC: 0.26
 - h. SHCG: 0.22
 - i. Visible Transmittance (VT): 23%
 - 2. View Windows and Door Glazing “GL1-B”: Insulating Glass Unit Makeup:
 - a. Basis-of-Design Product: Viracon VE 3-2M.
 - b. Overall Unit Thickness: 1-inch.
 - c. Outboard Lite: ¼” grey, tempered, VE3-2M coating on #2 surface.
 - d. Spacer: ½-inch.
 - e. Gas Fill: Air
 - f. Inboard Lite: ¼” clear, tempered.
 - g. SC: 0.27
 - h. SHCG: 0.23
 - i. Visible Transmittance (VT): 35%
 - 3. Ceramic-Coated Vision Glazing “GL1-C”: Insulating Glass Unit Makeup:
 - a. Basis-of-Design Product: Viracon VE 3-2M.
 - b. Overall Unit Thickness: 1-inch.

- c. Outboard Lite: ¼” grey, tempered, VE3-2M coating on #2 surface.
- d. Silk screened Ceramic Frit Coating: Surface 2, DOTS, 40% coverage, white.
- e. Spacer: ½-inch.
- f. Gas Fill: Air
- g. Inboard Lite: ¼” clear, tempered.
- h. SC: 0.27
- i. SHCG: 0.23
- j. Visible Transmittance (VT): 35%

2.3 GLASS TYPE 2 – LAMINATED GLASS (GL-2)

- A. Laminated Glass: ASTM C 1172, as indicated at interior non-rated doors and sidelights.
- B. Interlayers: Type as indicated below and of thickness indicated or required to comply with performance requirements and with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating to glass and installation:
 - 1. Polyvinyl butyral sheet, clear.
- C. Fabrication: Laminate glass to interlayers to produce laminated lites free of foreign substances, air, and glass pockets.
- D. Laminated-Glass Units: LHS (two or more lites of heat-strengthened float glass) consisting of two lites.
 - 1. Overall Unit Thickness: 7/16 inch.
 - 2. Outer Lite: Class 1 (clear) float glass.
 - 3. Thickness: 3/16 inch.
 - 4. Inner Lite: Class 1 (clear) float.
 - 5. Thickness: 3/16 inch
 - 6. Interlayers: Polyvinyl butyral sheet
 - 7. Thickness: 0.060 inch (1.52 mm).
 - 8. Interlayer Color: Clear
- E. Available Manufacturers:
 - 1. Viracon Inc., Owatonna, MN.
 - 2. Cardinal LG, Amery, WI.
 - 3. Arch aluminum & Glass, Waukesha, WI, or approved equal.

2.4 GLASS TYPE 3 - HEAT TREATED FLOAT GLASS (GL-3)

- A. Interior glazing at non-rated doors.
 - 1. ASTM C1048, Condition A (uncoated surfaces).
 - 2. Type I (transparent glass, flat).
 - 3. Class I (clear).
 - 4. Quality q3 (glazing select).

5. Fully tempered.
6. ¼" thick, unless otherwise indicated.

2.5 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glazing unit manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 1. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tape: Closed-cell, PVC foam tape; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
 1. Type 1, for glazing applications in which tape acts as the primary sealant.
Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.6 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials involved for glazing application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85 plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side-walking).
- F. Plastic Foam Joint Fillers: Preformed, compressible, resilient, non-staining, non-extruding, non-outgassing, strips of closed-cell plastic foam of density, size, and shape to control sealant depth and otherwise contribute to produce optimum sealant performance.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

- A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass from edge damage during handling and installation as follows:
 - 1. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.
 - 2. Remove damaged glass from Project site and legally dispose of off site. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.
- C. Install elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- D. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- E. Provide spacers for glass sizes larger than 50 united inches (length plus height) as follows:
 - 1. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- F. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.
- G. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

3.2 INSTALLATION

- A. Inspect substrate for glass products before installation work begins. Joints shall be clean, clear of obstructions, even, dry, and ready to receive glazing system and glass. Report any condition which would prevent proper glazing work to the Supervising Professional.
- B. Install glass products with specified glazing materials in accordance with the glazing materials manufacturer's instructions.
- C. After installation, carefully inspect all glass for damage. Any damaged glass shall be removed immediately and replaced with new.
- D. Clean glass products and associated panels after installation to remove excess glazing materials, fingerprints, dirt and construction markings to insure that material are free from imperfection.
- E. Provide protection to glass by adding paper streamers, tape, or other material to alert people using the building that the glass has been added to the opening.

END OF SECTION 08810

1.7.7. Section 08900 - Glazed Aluminum Curtain Walls

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 conventionally glazed aluminum curtain walls installed as stick systems.
- B. Related Sections include the following:
 - 1. Division 07 Section "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain-wall systems and for sealants to the extent not specified in this Section.
 - 2. Division 08 Section "Glazing" for insulating-glass requirements.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide glazed aluminum curtain-wall systems, including anchorage, capable of withstanding, without failure, the effects of the following:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 4. Dimensional tolerances of building frame and other adjacent construction.
 - 5. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferred to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d. Noise or vibration created by wind and thermal and structural movements. Loosening or weakening of fasteners, attachments, and other components.
 - e. Sealant failure.
- B. Structural Loads:
 - 1. Wind Loads: Additionally, extreme case wind loading for components and cladding at the corners of the building is 30 psf.

2. Seismic Loads: As indicated on Drawings
- C. Deflection of Framing Members:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch 19 mm, whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm)].
 - a. Operable Units: The window system shall be a concealed ventilator, project out as shown on the drawings, with no framing member exposed to the exterior for a clean uninterrupted sight line. The windows shall be Architectural Aluminum Windows in accordance with AAMA 501, Methods of Test for Metal Exterior Walls.
 3. Cantilever Deflection: Where framing members overhang an anchor point, limited to 2 times the length of cantilevered member, divided by 175.
- D. Thermal Movements: Provide glazed aluminum curtain-wall systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. Air Infiltration: Provide glazed aluminum curtain-wall systems with maximum air leakage of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283-84 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft.
- F. Water Penetration Under Static Pressure: Provide aluminum glazed curtain-wall systems that do not evidence water penetration when tested according to ASTM E 331 at a minimum differential static pressure of 15 lbf/sq. ft.
- G. Condensation Resistance: Provide glazed aluminum curtain-wall systems with condensation-resistance factor (CRF) of not less than 55 when tested according to AAMA 1503.
- H. Average Thermal Conductance: Provide glazed aluminum curtain-wall systems with average U-factor of not more than 0.66 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

1.4 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.
- B. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of glazed aluminum curtain-wall systems.
 - 1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of systems, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
 - 1. Joinery.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
- F. Welding certificates.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for glazed aluminum curtain-wall systems.
- H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Capable of assuming engineering responsibility and performing Work of this Section and who is acceptable to manufacturer.
 - 1. Engineering Responsibility: Preparation of data for glazed aluminum curtain-wall systems including the following:
 - a. Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 699 for testing indicated.

- C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' 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.
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code--Aluminum."

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain-wall systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of glazed aluminum curtain-wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals and other materials beyond normal weathering.
 - d. Water leakage.
 - e. Failure of operating components to function normally.
 - 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for glazed aluminum curtain-wall systems is based on ERCO System 5600 2 1/4" x 7". Subject to compliance with

requirements, provide the named product or a comparable product by one of the following:

1. CMI Architectural Products, Inc.
2. EFCO Corporation.
3. Kawneer.
4. Tubelite, Inc.
5. United States Aluminum.
6. Vistawall Architectural Products.
7. Wausau Window and Wall Systems.

2.2 FRAMING SYSTEMS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221 (ASTM B 221M).
 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 4. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
- B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
 1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 2. Cold-Rolled Sheet and Strip: ASTM A 611.
 3. Hot-Rolled Sheet and Strip: ASTM A 570/A 570M.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.
- D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 1. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 2. Reinforce members as required to receive fastener threads.
 3. Use exposed fasteners with countersunk Phillips screw heads.
 4. Finish exposed portions to match framing system.
 5. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
- E. Anchors: Three-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- F. Concealed Flashing: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding flashing compatible with adjacent materials.
- G. Framing Gaskets: As recommended by manufacturer for joint type.
- H. Framing Sealants: As recommended by manufacturer for joint type.

2.3 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer for joint type and as follows:
 1. Structural Sealant: ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in curtain-wall systems indicated.
 - a. Color: Black.
 - b. Type: Single. component.
 - c. Minimum Tensile Strength: 100 psi (690 kPa).
 - d. Modulus of Elasticity: As required by structural-sealant-glazed curtain-wall system design to meet performance requirements.

2.4 VENTING WINDOWS

- A. Venting Windows: The window system shall be a concealed ventilator, project out as shown on the drawings, with no framing member exposed to the exterior for a clean uninterrupted sight line. The windows shall be Architectural Aluminum Windows in accordance with AAMA 501, Methods Of Test For Metal Exterior Walls.
 1. Extruded aluminum profiles shall be 6063-TS5 alloy and tempered (ASTM B221 G.S. 10A-T5).
 2. The frame adapter depth shall not be less than 2 ¼".
 3. The ventilator depth shall not be less than 2".
 4. All framing members shall have a minimum wall thickness of 0.125" and shall provide the structural strength sufficient to meet the specified performance requirements.

5. All ventilators shall be tubular.
6. Weather-stripping shall be resilient elastomer.
7. Fasteners: Where exposed, shall be stainless steel.
8. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
9. Provide cast white bronze cam locking handles.
10. Provide steel 4 bar hinges.

2.5 DOORS

- A. Doors: Provide manufacturer's standard 1-3/4-inch- (44.5-mm-) thick glazed doors with minimum 0.125-inch- (3.2-mm-) thick, extruded tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie-rods.
 1. Glazing Stops and Gaskets: Provide manufacturer's standard snap-on extruded-aluminum glazing stops and preformed gaskets.
 2. Stile Design: Wide stile; over 4 inches (101.6 mm) wide.
- B. Brackets and Reinforcements: Provide manufacturer's standard brackets and reinforcements that are compatible with adjacent materials. Provide non-staining, nonferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 1. Reinforce members as required to retain fastener threads.
 2. Do not use exposed fasteners, except for hardware application. For hardware application, use countersunk Phillips flat-head machine screws finished to match framing members or hardware being fastened, unless otherwise indicated.
- D. Weather Stripping: Manufacturer's standard replaceable weather stripping as follows:
 1. Compression Weather Stripping: Molded neoprene complying with ASTM D 2000 requirements or molded PVC complying with ASTM D 2287 requirements.
 2. Sliding Weather Stripping: Wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing complying with AAMA 701 requirements.

2.6 HARDWARE

- A. General: Provide heavy-duty hardware units indicated in sizes, number, and type recommended by manufacturer for entrances indicated. Finish exposed parts to match door finish, unless otherwise indicated. Hardware applies to the following doors:

1. Door 100.
 2. Door 112A.
 3. Door 113.
- B. Offset Pivots: ANSI/BHMA A156.4, Grade 1 with exposed parts of cast-aluminum alloy. Provide top, bottom, and intermediate pivots at each door leaf.
- C. Closers, General: Comply with manufacturer's recommendations for closer size, depending on door size, exposure to weather, and anticipated frequency of use.
1. Closing Cycle: Comply with requirements of authorities having jurisdiction or the Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," whichever are more stringent.
 2. Opening Force: Comply with the following maximum opening-force requirements for locations indicated:
 - a. Exterior Doors: 15 lbf (67 N).
 - b. Interior Doors: 5 lbf (22.2 N).
 3. Surface Closer: Norton 8301 BF, LCN, Commercial Architectural Products, Inc., Butler Manufacturing Company, or approved equal, with standard back-checks and hold-open.
- D. Push/Pulls
1. Kawneer CPII push bar and C09 pull; Commercial Architectural Products, Inc., Butler Manufacturing Company, or approved equal, clear anodized finish.
- E. Protection Plates, mounted behind both the push/pull on the vertical stile.
1. Hagar 50T, 3-inch x 12-inch; 32D finish, Commercial Architectural Products, Inc., Butler Manufacturing Company, or approved equal.
- F. Latch Paddle Device
1. Adams Rite 4590, Commercial Architectural Products, Inc., Butler Manufacturing Company, or approved equal. Latch paddle shall completely disengage the deadbolt/latch to permit egress from the interior of the building at all times, regardless of whether the deadbolt is thrown.
- H. Deadbolt/Latch
1. Adams Rite MS+1890 with cylinders both sides; Commercial Architectural Products, Inc., Butler Manufacturing Company, or approved equal; satin aluminum finish.
- I. Latch Strike
1. Adamsrite 4505, Commercial Architectural Products, Inc., Butler Manufacturing Company, or approved equal. Armored Strike (Flat Strike).

- J. Cylinders
 - 1. Standard 6-pin mortised cylinders complying with ANSI/BHMA A156.5, GRADE I requirements. Provide cylinders on both sides of exterior entry door. Finalize keying required with the owner.
- K. Cylinder Guard
 - 1. Manufacturer's standard hardened-steel security ring with retainer plate for inside stile wall that protects lock cylinder from removal.
- L. Thresholds: At exterior doors, provide manufacturer's standard threshold with cutouts coordinated for operating hardware, with anchors and jamb clips, and not more than ½ -inch-(12.7-mm-) high with beveled edges providing a floor level change with a slope of not more than 1:2, and in the following materials:
 - 1. Material: Aluminum, mill finish.
- M. Weather Sweeps: Manufacturer's standard weather sweep for application to exterior door bottoms and with concealed fasteners on mounting strips. Select one closer type below. Verify options available for selected closer type with manufacturers selected.

2.7 ACCESSORY MATERIALS

- A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.8 FABRICATION

- A. Form aluminum shapes before finishing.
- B. Fabricate components that, when assembled, have the following characteristics:
 - 1. Sharp profiles, straight and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to prevent glazing-to-glazing contact and to maintain required glazing edge clearances.
 - 6. Provisions for reglazing from interior.
- C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

- D. Factory-Assembled Frame Units:
 - 1. Rigidly secure non-movement joints.
 - 2. Seal joints watertight, unless otherwise indicated.
 - 3. Pressure equalize system at its interior face.
 - 4. Install glazing to comply with requirements in Division 08 Section "Glazing."
- E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure non-movement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 - 7. Seal joints watertight, unless otherwise indicated.

- B. Metal Protection:
 - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
 - 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install sealants as specified in this section and in Division 07 Section "Joint Sealants."
- G. Erection Tolerances: Install glazed aluminum curtain-wall systems to comply with the following maximum tolerances:
 - 1. Plumb: 1/8 inch in 10 feet (3 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
 - 2. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
 - 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (13 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (13 to 25 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
 - c. Where surfaces are separated by reveal or protruding element of 1 inch (25 mm) wide or greater, limit offset from true alignment to 1/4 inch (6 mm).
 - 4. Location: Limit variation from plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

END OF SECTION 08900

1.8. Division 9 – Finishes

1.8.1. Section 09260 – Gypsum Board Assemblies

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum wallboard.
 - 2. Non-load-bearing steel framing.
 - 3. Fire Rated ceiling assemblies.
 - 4. Gypsum board ceiling assemblies.
- B. Related Sections include the following:
 - 1. Division 6 Section "Miscellaneous Carpentry" for wood framing and furring, and gypsum sheathing applied over wood framing.
 - 2. Division 7 Section "Building Insulation" for insulation and vapor retarders installed in gypsum board assemblies.
 - 3. Division 5 Section "Structural Steel" for load-bearing steel framing.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- A. Product Data for each scheduled product.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory."

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 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 Framing and Furring:
 - a. Clark Steel Framing Systems.
 - b. Consolidated Systems, Inc.
 - c. Dale Industries, Inc. - Dale/Incor.
 - d. Dietrich Industries, Inc.
 - e. MarinoWare; Division of Ware Ind.
 - f. National Gypsum Company.
 - g. Scafco Corporation.
 - h. Unimast, Inc.
 - i. Western Metal Lath & Steel Framing Systems.
 - 2. Gypsum Board and Related Products:
 - a. American Gypsum Co.
 - b. G-P Gypsum Corp.
 - c. National Gypsum Company.
 - d. United States Gypsum Co.

2.2 STEEL SUSPENDED CEILING FRAMING

- A. Components, General: Comply with ASTM C 754 for conditions indicated.
- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

- C. Hangers: As follows:
 - 1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch (1.37 mm), a minimum 1/2-inch- (12.7-mm-) wide flange, with ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized zinc coating.
 - 1. Depth: 1-1/2 inches (38.1 mm).
- E. Furring Channels (Furring Members): Commercial-steel sheet with ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized zinc coating.
 - 1. Hat-shaped, rigid furring channels: ASTM C 645, 7/8 inch deep.

2.3 STEEL PARTITION AND SOFFIT FRAMING

- A. Components, General: As follows:
 - 1. Comply with ASTM C 754 for conditions indicated.
 - 2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized zinc coating.
- B. Steel Studs and Runners: ASTM C 645.
 - 1. Minimum base metal thickness: 0.0312 inch, 20 gauge.
 - 2. Depth 2-1/2" typical, or as indicated on the drawings.
- C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base Metal Thickness: 0.0359 inch 20 gauge.
- D. Cold-Rolled Channel Bridging: 0.0538-inch (1.37-mm) bare steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flange.
 - 1. Depth: 1-1/2 inches (38.1 mm).
 - 2. Clip Angle: 1-1/2 by 1-1/2 inch (38.1 by 38.1 mm), 0.068-inch- (1.73-mm-) thick, galvanized steel.
- E. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.4 INTERIOR GYPSUM WALLBOARD

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Gypsum Wallboard: ASTM C 36.

1. Type X throughout:
 - a. Thickness: 5/8" inch, unless otherwise indicated.
 - b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
 - c. Location: throughout.

2.5 WATER RESISTANT GYPSUM BOARD

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M.
 1. Core: 5/8 inch (15.9 mm), Type X.
 2. Location: On interior walls and ceilings of toilet rooms, janitor's closets indicated to be gypsum board, or as otherwise indicated.

2.6 GYPSUM BOARD SHAFT-WALL ASSEMBLIES (HORIZONTAL)

- A. Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.
 1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
 2. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.
- B. Gypsum Liner Panels: Comply with ASTM C 442/C 442M.
 1. Type X: Manufacturer's proprietary liner panels with moisture-resistant paper faces.
 - a. Core: 1 inch (25.4 mm) thick.
 - b. Long Edges: Double bevel.
- C. Gypsum Board: In number of layers and thickness as indicated on drawings.

2.7 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 2. Shapes:
 - a. Cornerbead: Use at outside corners, unless otherwise indicated.
 - b. LC-Bead (J-Bead): Use at exposed panel edges.
 - c. L-Bead: Use at panel edges or as recommended by gypsum panel manufacturer.
 - d. U-Bead: Use at panel edges or as recommended by gypsum panel manufacturer.
 - e. Expansion (Control) Joint: One-piece control joint formed with V-shaped slot and removable strip covering slot opening. Use where indicated or recommended by gypsum panel manufacturer.

- f. Curved-Edge Cornerbead: With notched or flexible flanges; use at curved openings.
- B. Exterior Trim: ASTM C 1047.
 - 1. Material: Hot-dip galvanized steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead: Use at outside corners.
 - b. LC-Bead (J-Bead): Use at exposed panel edges.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening. Use where indicated or recommended by gypsum panel manufacturer.
 - 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.8 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper or Fiberglass Drywall Tape.
 - 2. Exterior Gypsum Soffit Board: Paper or Fiberglass Drywall Tape.
 - 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
 - 4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound formulated for uses indicated.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

2.9 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Isolation Strip at Exterior Walls:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.
- E. Thermal Insulation: As specified in Division 7 Section "Building Insulation."
- F. Polyethylene Vapor Retarder: As specified in Division 7 Section "Building Insulation."

2.10 TEXTURE FINISHES

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Unaggregated Texture Coating, Wall and Ceiling Finish:
 - a. United States Gypsum Co.; SHEETROCK Wall and Ceiling texture (Multi-Purpose), National Gypsum Company, Georgia-Pacific Corp. or approved equal.
- B. Primer: As recommended by textured finish manufacturer.
- C. Un-Aggregated Wall and Ceiling Finish: Water-based, job-mixed, un-aggregated finish with flame-spread and smoke-developed indices of not more than 25 when tested according to ASTM E 84.
 - 1. Texture: Fine Orange Peel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."
- C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.
 - 1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
 - 2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
 - a. Use deep-leg deflection track where indicated.
- D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.4 INSTALLING STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Suspend ceiling hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or

equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 4. Do not attach hangers to steel deck tabs.
 5. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 6. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member and transversely between parallel members.
- C. Sway-brace suspended steel framing with hangers used for support.
- D. Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.
- E. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
1. Hangers: 48 inches (1219 mm) o.c.
 2. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.
 3. Furring Channels (Furring Members): 24 inches (610 mm) o.c.
- F. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.5 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
1. Where studs are installed directly against exterior walls, install asphalt-felt or foam-gasket isolation strip between studs and wall.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at

suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. Cut studs 1/2 inch (13 mm) short of full height to provide perimeter relief.
 2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
 - a. Terminate partition framing at suspended ceilings where indicated.
- D. Install steel studs and furring at the following spacings:
1. Single-Layer Construction: 16 inches (406 mm) o.c., unless otherwise indicated.
 2. Multilayer Construction: 16 inches (406 mm) o.c., unless otherwise indicated.
 3. Cementitious Backer Units: 16 inches (406 mm) o.c., unless otherwise indicated.
- E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- F. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
1. Install two studs at each jamb, unless otherwise indicated.
 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint.
 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- G. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- H. Polyethylene Vapor Retarder: Install to comply with requirements specified in Division 7 Section "Building Insulation."

3.6 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

- B. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- F. Attach gypsum panels to framing provided at openings and cutouts.
- G. Form control and expansion joints with space between edges of adjoining gypsum panels.
- H. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- I. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- J. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
 - 1. Space screws a maximum of 12 inches (304.8 mm) o.c. for vertical applications, or as recommended by manufacturer, whichever is more stringent.

- K. Space fasteners in panels that are tile substrates a maximum of 8 inches (203.2 mm) o.c.

3.7 PANEL APPLICATION METHODS

- A. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
 - b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
- B. Multi-layer Application on Ceilings: Apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
- C. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- D. Multi-layer Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- E. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.8 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

3.9 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 - 1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 - 2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated.
 - 3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.

3.10 APPLYING TEXTURE FINISHES

- A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.
- B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.
- C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture finish manufacturer's written recommendations.

3.11 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Supervising Professional will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.

1. Notify Supervising Professional seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
2. Before notifying Supervising Professional, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air-duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control-air tubing.
 - f. Installation of ceiling support framing.

END OF SECTION 09260

1.8.2. Section 09310 - Tile

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Glazed wall tile.
 - 2. Quarry tile.
 - 3. Liquid waterproofing membrane.
- B. Related Sections include the following:
 - 1. Division 10 Section "Toilet and Bath Accessories" for coordinating installation of accessories with tile.
 - 2. Division 9 Section "Gypsum Board Assemblies" for tile substrate information.
 - 3. Division 3 Section "Cast-In-Place Concrete" for tile substrate information.

1.3 DEFINITIONS

- A. Facial Dimension: Nominal tile size as defined in ANSI A137.1.

1.4 SUBMITTALS

- A. Product Data: For each type of tile, mortar, grout, sealers, and other products specified.
- B. Tile Samples for Initial Selection: Manufacturer's color charts consisting of actual tiles or sections of tiles showing the full range of colors, textures, and patterns available for each type and composition of tile indicated. Include Samples of accessories involving color selection.
- C. Grout Samples for Initial Selection: Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.
- D. Penetrating sealer: Submit manufacturer's independent test data, manufacturer's product data including Material Safety Data Sheets. Submit a complete set of the manufacturer's application recommendations.

- E. Care and Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Source Limitations for Tile: Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.
- C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- D. Source Limitations for Other Products: Obtain each of the following products specified in this Section from one source and by a single manufacturer for each product:
 - 1. Joint sealants.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.
- B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile, sealers, or other specified products until construction in spaces is completed and ambient temperature and humidity conditions are being maintained to comply with referenced standards and manufacturer's written instructions.

1.8 EXTRA MATERIALS

- A. Deliver any remainders from open boxes to Owner. Package with protective covering for storage, and identify with labels describing contents.

1.9 QUALITY ASSURANCE

- A. Penetrating sealer mock-up: Apply a sample of penetrating sealer at project site as directed, according to manufacturer's recommendations. During application sample, note the rate of product use and result. After 24 hours, test for stain resistance using likely contaminants. Deliver to Owner's Representative a copy of manufacturer's recommendations, together with a report of coverage rate and stain resistance of sample. Sample will be reviewed by the Owner's Representative and, if approved, shall become the criteria for acceptance of work.

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. Tile Products:
 - a. American Marrazzi Tile, Inc.
 - b. American Olean Tile Company.
 - c. Buchtal Corporation USA.
 - d. Cerim-Floor Gres Ceramiche.
 - e. Crossville Ceramics.
 - f. Dal-Tile Corporation.
 - g. Florida Tile Industries, Inc.
 - h. GranitiFiandre.
 - i. Interceramics, USA.
 - j. KPT, Inc.
 - k. Laufen International, Inc.
 - l. Lonestar Ceramics Company.
 - m. Mannington Ceramic Tile.
 - n. Metropolitan Ceramics.
 - o. Monarch Tile, Inc.
 - p. Quarry Tile Company.
 - q. Seneca Tiles, Inc.
 - r. Summitville Tiles, Inc.
 - s. United States Ceramic Tile Company.
 - 2. Tile-Setting and Grouting Materials:
 - a. American Olean Tile Company.
 - b. Atlas Minerals & Chemicals, Inc.
 - c. Boiardi Products Corporation.
 - d. Bonsal: W.R. Bonsal Company.
 - e. Bostik.
 - f. C-Cure Corporation.
 - g. Custom Building Products.
 - h. Dal-Tile Corporation.

- i. DAP, Inc.
- j. Laticrete International, Inc.
- k. Mapei Corporation.
- l. Southern Grouts & Mortars, Inc.
- m. Summitville Tiles, Inc.
- n. TEC Incorporated.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.
- C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
 - 1. Provide Supervising Professional's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.
 - 2. Provide tile trim and accessories that match color and finish of adjoining flat tile.
- D. Factory Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples.

2.3 TILE PRODUCTS

- A. Glazed Wall Tile (CT): Provide flat tile complying with the following requirements:
 - 1. Module Size: 8 by 8 inches.
 - 2. Thickness: 5/16 inch (8 mm).
 - 3. Face: Plain with modified square edges or cushion edges.
 - 4. Mounting: Factory back-mounted.
 - 5. Available Product: KPT Enviro, Class IV+ Heavy Commercial, or approved equal.
 - 6. Colors: Install multiple colors and patterns as indicated. Provide full range of manufacturer's colors, textures, and finishes for Supervising Professional's Selection.

- B. Unglazed Quarry Tile (QT): Provide flat tile complying with the following requirements:
 - 1. Facial Dimensions: 6 x 6 inches.
 - 2. Thickness: 1/2 inch
 - 3. Face: Plain with square edges.
 - 4. For latex-portland cement mortared and grouted paver tile, pre-coat with temporary protective coating, if recommended by manufacturer or installer.
 - 5. Available Product: Dal-Quarry Tile or approved equal.
 - 6. Colors: Install multiple colors and patterns as indicated. Provide full range of manufacturer's colors, textures, and finishes for Supervising Professional's selection.
- C. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:
 - 1. Size: As indicated below:
 - a. 5 1/2-in high by 6-inches wide sanitary base for QT.
 - b. 6-in high by 8-in wide sanitary base for CT.
 - 2. Shapes: As follows, selected from manufacturer's standard shapes:
 - a. Base for Portland Cement Mortar Installations: Coved.
 - b. Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose.
 - c. External Corners for Thin-Set Mortar Installations: Surface bullnose.
 - d. Internal Corners: Field-buttet square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

2.4 WATERPROOFING FOR THIN-SET TILE INSTALLATIONS

- A. General: Provide products that comply with ANSI A118.10 and the descriptions in this Article.
- B. Latex-Rubber Waterproofing: Manufacturer's standard factory-packaged, job-mixed, proprietary, 2-part formulation consisting of liquid-latex rubber and powder for trowel application and glass-fiber-fabric reinforcing.

2.5 SETTING MATERIALS

- A. Latex-Portland Cement Mortar: ANSI A118.4, composed as follows:
 - 1. Mixture of Dry-Mortar Mix and Latex Additive: Mixture of prepackaged dry-mortar mix and liquid-latex additive complying with the following requirements:
 - a. Latex Additive: Manufacturer's standard.
 - b. For wall applications, provide nonsagging, latex-portland cement mortar complying with ANSI A118.4 for mortar of this type defined in Section F-2.1.2.

- B. Portland Cement Mortar (Thickset) Installation Materials: AANSI A108.1A and as specified below:
1. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.
 2. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches (50.8 by 50.8mm) by 0.062-inch (1.57-mm) diameter; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.
 3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.
 4. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
 5. Setting Bed Thickness: 2"

2.6 GROUTING MATERIALS

- A. At CT-1: Latex-Portland Cement Grout: ANSI A118.6 for materials described in Section H-2.4, composed as follows:
1. Mixture of Dry-Grout Mix and Latex Additive: Mixture of factory-prepared, dry-grout mix and latex additive complying with the following requirements:
 - a. Unsanded Dry-Grout Mix: Dry-set grout complying with ANSI A118.6 for materials described in Section H-2.3, for joints 1/8 inch (3.2 mm) and narrower.
 - b. Latex Additive: Manufacturer's standard.
 - c. Color: As selected from Manufacturers full range of color choices.
- B. At CT-2 and QT: Standard Sanded Cement Grout complying with ANSI 118.6. Color as selected from manufacturer's full range of color choices.

2.7 ELASTOMERIC SEALANTS

- A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that comply with requirements of ASTM C 920 as referenced by Type, Grade, Class, and Uses.
- B. Vertical and Horizontal, Non-traffic Surface Sealant.
1. One-Part Mildew-Resistant Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and temperature extremes.
 2. Color to match grout.
 3. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

- a. "Dow Corning 786"; Dow Corning Corp.
 - b. "SCS 1702"; General Electric Co.
 - c. "863 #345 White"; Pecora Corp.
 - d. "Rhodorsil 6B White"; Rhone-Poulenc Inc.
 - e. "Proglaze White"; Tremco Corp.
 - f. Sonneborne NP-1
- C. Horizontal Traffic Surface Sealant (floors).
 - 1. One-Part, Mildew-Resistant Urethane Sealant: Type S; Grade P or NS; Class 25; Uses T, M, O.
 - 2. Color to match grout.
 - 3. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following.
 - a. "Vulkem 116"; Mameco.
 - b. Vulkem 45; Mameco.
 - c. "Sikaflex-1a"; Sika.
 - d. Sonneborne NP-1
 - e. Sonneborne SL-2
 - f. Chem-Calk 950; Bostik.

2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

2.9 PENETRATING SEALERS FOR UNGLAZED QUARRY TILE

- A. General: Provide water-based, no-sheen, natural-look penetrating sealer formulated to provide maximum stain protection and to allow moisture vapor transmission. To be used as both a pre-grouting sealer over clean tile surfaces a minimum of 1 hour prior to grouting, and also as a final sealer at quarry tile installations. Tile installer shall verify compatibility of product with tile manufacturer.
- B. Available Products: Sealer's Choice 15 Gold: Aqua Mix Inc., 9419 AnnStreet, Santa Fe Springs, CA 90670, Phone 562.946.6877; Crystal Glaze by Aldon Chemical; Heavy Duty Grout Sealer by Stone Tech Professional; or equal.
- C. Water: Potable and fresh.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 series of tile installation standards for installations indicated.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
 - 3. Verify that joints, cracks, and slopes in tile substrates are coordinated with tile joint locations; if not coordinated, adjust latter in consultation with Supervising Professional. Cut tile as required to accommodate these conditions.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds, and other substances that contain soap, wax, oil, or silicone and are incompatible with tile-setting materials by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.
- B. Provide concrete substrates for tile floors installed with dry-set or latex-portland cement mortars that comply with flatness tolerances specified in referenced ANSI A108 series of tile installation standards for installations indicated.
 - 1. Use trowelable leveling and patching compounds per tile-setting material manufacturer's written instructions to fill cracks, holes, and depressions.
 - 2. Remove protrusions, bumps, and ridges by sanding or grinding.
- C. Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, verify that tile has been blended in the factory and packaged so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 series of tile installation standards in "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are the same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- F. Lay out tile wainscots to next full tile beyond dimensions indicated.
- G. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Locate joints at intersection of wall tile and floor tile as deemed appropriate by tile installers.
 - 2. Locate joints in tile surfaces directly above joints in concrete substrates.
- H. Grout tile to comply with the requirements of the following tile installation standards:
 - 1. For ceramic tile grouts (sand-portland cement, dry-set, commercial portland cement, and latex-portland cement grouts), comply with ANSI A108.10.

3.4 WALL TILE INSTALLATION

- A. Install types of tile designated for wall installations to comply with requirements in the Ceramic Tile Wall Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
- B. Joint Widths: Follow manufacturer's published recommendations, and as noted below.
 - 1. 8 x 8 wall tile joints shall be 1/4" wide.
 - 2. 6 x 6 floor quarry tiles joints shall be 1/4" wide.

3.5 QUARRY TILE FLOOR SEALING (PRE-GROUTING & FINAL)

- A. Examination, Preparation, Application, and Protection: Follow manufacturer's published recommendations, and as noted below.

3.6 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove latex-portland cement grout residue from tile as soon as possible.
 - 2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.
- B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work.
- C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure tile is without damage or deterioration at the time of Substantial Completion.
 - 1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
 - 2. Prohibit foot and wheel traffic from tiled floors for at least 7 days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.7 OWNER TRAINING

- A. Instruct the Owner in the care and maintenance of tile surfaces. Training shall include at a minimum, recommended cleaning cleaning schedules, products, and practices. Schedule training at the Owner's convenience, with at least 7 day's advanced notice.

END OF SECTION 09310

1.8.3. Section 09511 – Acoustical Panel Ceilings

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes ceilings consisting of acoustical panels and exposed suspension systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product specified, clearly referenced to specification by type, and cross-referenced to room finish schedule.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of actual acoustical panels or sections of acoustical panels, suspension systems, and moldings showing the full range of colors, textures, and patterns available for each type of ceiling assembly indicated.
- C. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed acoustical panel ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Source Limitations for Ceiling Units: Obtain each acoustical ceiling panel from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
- C. Source Limitations for Suspension System: Obtain each suspension system from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable Wisconsin Administrative Code for fire rated assembly and combustibility requirements for materials.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.8 COORDINATION

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

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Furnish Owner one carton of acoustic panels for each type of acoustical panel specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, those indicated for each designation in the Acoustical Panel Ceiling Schedule at the end of Part 3.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with publications referenced below per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - 1. Standard for Ceiling Suspension System Installations: Comply with ASTM C 636.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers

- to support ceiling loads within performance limits established by referenced standards and publications.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure; that are appropriate for substrate; and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; and provide hangers not more than 8 inches (200 mm) from ends of each member.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Where STC rated partitions are indicated, apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed. See Division 9 Section - Gypsum Board Assemblies - for acoustical sealant requirements.
 2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m). Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 3. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated or required.

3.4 CLEANING

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

3.5 ACOUSTICAL PANEL CEILING SCHEDULE

- A. SAT-A: Mineral-Base Acoustical Panels for Acoustical Panel Ceiling. Where this designation is indicated, provide acoustical panels complying with the following:
1. Products: USG Sandrift Clima plus.
 2. Color: White.
 3. Edge Detail: Shadowline.
 4. Thickness: 3/4 inch (19 mm).
 5. Size: 24 by 24 inches (610 by 610 mm).
- B. Suspension System for Acoustical Panel Ceilings SAT-A: Provide acoustical panel ceiling suspension system complying with the following:
1. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G01 (Z001) coating designation, with prefinished 15/16-inch-wide metal caps on flanges; other characteristics as follows:
 - a. Structural Classification: Intermediate-duty system.
 - b. End Condition of Cross Runners: Override (stepped) or butt-edge type, as standard with manufacturer.
 - c. Cap Material: Steel or aluminum sheet as standard with manufacturer.
 - d. Cap Finish: Painted white.
 2. Edge Trim: Compatible with manufacturer's suspension system.
 - a. Products: USG Compasso Edge trim.
 - b. Height: 4".
 - c. Color: White.
 - d. Location: At perimeter of suspended ceiling "clouds" indicated on drawings.

END OF SECTION 09511

1.8.4. Section 09653 – Resilient Wall Base & Accessories

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 wall base.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide resilient stair accessories with a critical radiant flux classification of Class I, not less than 0.45 W/sq. cm, as determined by testing identical products per ASTM E 648 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.6 PROJECT CONDITIONS

- A. Maintain temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.

- B. After postinstallation period, maintain temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C) .
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturer's products that may be incorporated into the Work include, but are not limited to,
 - 1. Armstrong World Industries, Inc.
 - 2. Azrock Commercial Flooring, DOMCO.
 - 3. Endura.
 - 4. Johnsonite.
 - 5. Mondo Rubber International, Inc.
 - 6. Roppe Corporation
 - 7. VPI, LLC, Floor Products Division

2.3 RESILIENT WALL BASE (SVB).

- A. Wall Base: ASTM F 1861.
- B. Type (Material Requirement): TV (vinyl).
- C. Group (Manufacturing Method I (solid).
- D. Style: Straight (toeless).
- E. Minimum Thickness: 0.125 inch (3.2 mm).
- F. Height: 4 inches (102 mm).
- G. Lengths: Cut lengths, 48 inches (1219 mm) long.
- H. Outside Corners: Job formed.
- I. Inside Corners: Job formed or premolded.
- J. Surface: Smooth.
- K. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturers for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.
- B. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- C. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.
- D. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
 - 1. Do not install resilient products until they are the same temperature as the space where they are to be installed.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 RESILIENT WALL BASE INSTALLATION

- A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- D. Do not stretch wall base during installation.
- E. On masonry surfaces or other similar irregular substrates, fill voids along top edge of wall base with manufacturer's recommended adhesive filler material.
- F. Pre-molded Corners: Install pre-molded corners before installing straight pieces.
- G. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible. Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after completing resilient product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
 - a. Do not wash surfaces until after time period recommended by manufacturer.
- B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.
 - 1. Apply protective floor polish to stair accessory surfaces that are free from soil, visible adhesive, and surface blemishes if recommended in writing by manufacturer.

- a. Use commercially available product acceptable to manufacturer.
Coordinate selection of floor polish with Owner's maintenance service.

END OF SECTION 09653

1.8.5. Section 09680 - Carpet

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 carpet and installation.
- B. Related Sections:
 - 1. Division 3 Sections for curing compounds and other concrete treatments for compatibility with carpet adhesives.

1.3 SUBMITTALS

- A. Product Data for each type of carpet material specified. Submit manufacturer's printed data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.
- B. Samples for initial selection in the form of manufacturer's samples of materials showing the full range of colors, textures, and patterns available for each type of carpet indicated.
- C. Schedule of carpet using same room designations indicated on Drawings.
- D. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Obtain each type of carpet from one source and by a single manufacturer.
- B. Carpet Fire-Test-Response Characteristics: Provide carpet with the following fire-test-response characteristics as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify carpet with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface Flammability: Passes CPSC 16 CFR, Part 1630.
 - 2. Flame Spread: 25 or less per ASTM E 84.
 - 3. Smoke Developed: 450 or less per ASTM E 84.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 5: "Storage and Handling."
- B. Deliver materials to Project site in original factory wrappings and containers, labeled with identification of manufacturer, brand name, and lot number.
- C. Store materials on-site in original undamaged packages, inside well-ventilated area protected from weather, moisture, soilage, extreme temperatures, and humidity. Lay flat, with continuous blocking off ground. Maintain minimum temperature of 68degrees F (20 degrees C) at least 3 days prior to and during installation in area where materials are stored.

1.6 PROJECT CONDITIONS

- A. General: Comply with CRI 104, Section 6: "Site Conditions."
- B. Space Enclosure and Environmental Limitations: Do not install carpet until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.
- C. Subfloor Moisture Conditions: No condensation within 48 hours on underside of 4-foot by 4-foot polyethylene sheet, fully taped at perimeter to substrate.
- D. Subfloor Alkalinity Conditions: A pH range of 5 to 9 when subfloor is wetted with potable water and pHydriion paper is applied.

1.7 WARRANTY

- A. Special Carpet Warranty: Submit a written warranty executed by carpet manufacturer and Installer agreeing to repair or replace carpet that does not meet requirements or that fails in materials or workmanship within the specified warranty period. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.
- B. Warranty Period: 10 year texture and color retention, lifetime wear, lifetime edge and ravel & zippering, and lifetime static, from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Deliver any remnants of carpet greater than 4'-0" in least dimension to owner. Package with protective covering for storage; identify with labels clearly describing contents.

PART 2 - PRODUCTS

2.1 CARPET

- A. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the products specified in each carpet Product Data sheet at end of this Section.

2.2 INSTALLATION ACCESSORIES

- A. Concrete-Slab Primer: Non-staining type as recommended by the carpet manufacturer.
- B. Trowelable Underlayments and Patching Compounds: As recommended by the carpet manufacturer.
- C. Adhesives: Water-resistant, mildew-resistant, non-staining type to suit products and subfloor conditions indicated and to comply with flammability requirements for installed carpet as recommended by the carpet manufacturer.
- D. Seaming Cement: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine subfloors and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting performance of carpet. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Verify that subfloors and conditions are satisfactory for carpet installation and comply with requirements specified in this Section and those of the carpet manufacturer.

3.2 PREPARATION

- A. General: Comply with carpet manufacturer's installation recommendations to prepare substrates indicated to receive carpet installation.
- B. Level subfloor within 1/4 inch in 10 feet (6 mm in 3 m), noncumulative, in all directions. Sand or grind protrusions, bumps, and ridges. Patch and repair cracks and rough areas. Fill depressions.
 - 1. Use leveling and patching compounds to fill cracks, holes, and depressions in subfloor as recommended by the carpet manufacturer.
- C. Remove subfloor coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone.
- D. Broom or vacuum clean subfloors to be covered with carpet. Following cleaning, examine subfloors for moisture, alkaline salts, carbonation, or dust.
- E. Concrete-Subfloor Preparation: Apply concrete-slab primer, according to manufacturer's directions, where recommended by the carpet manufacturer.

3.3 INSTALLATION

- A. Direct Glue-Down Installation: Comply with CRI 104, Section 8: "Direct Glue-Down."
- B. Comply with carpet manufacturer's recommendations for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under door in closed position. Do not bridge building expansion joints with continuous carpet.
- C. Where demountable partitions or other items are indicated for installation on top of finished carpet floor, install carpet before installation of these items.
- D. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- E. At wood flooring area, roll carpet edge to provide a hemmed edge to prevent pull-back from shrinkage or traffic.
- F. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Install pattern parallel to walls and borders.

3.4 CLEANING

- A. Perform the following operations immediately after completing installation.
 - 1. Remove visible adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
 - 2. Remove protruding yarns from carpet surface.
 - 3. Vacuum carpet using commercial machine with face-beater element.

3.5 PROTECTION

- A. General: Comply with CRI 104, Section 15: "Protection of Indoor Installation."
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure carpet is without damage or deterioration at the time of Substantial Completion.

PRODUCT DATA SHEET 1 - CARPET

- A. Carpet Designation: CPT
 - 1. Basis of Design Product: "Basare" by Lees or a comparable product of one of the following:
 - a. Crossley, A Tandus Group Company.
 - b. Mohawk.
 - 2. Face Yarn: Antron Legacy with Dura Tech Soil Protection by DuPont.
 - 3. Construction: Tufted.
 - 4. Surface Texture: Textured loop graphics.
 - 5. Gauge: 1/8".
 - 6. Finished Pile Thickness: 0.174" average.
 - 7. Face Yarn Weight 30 oz./sq.yd.
 - 8. Total weight: 87.10 oz./sq.yd.
 - 9. Backing Material: Unibond by "Lees".
 - 10. Width: 12-foot.
 - 11. Performance Characteristics: As follows:
 - a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm per ASTM E 648.
 - 12. Color and Pattern: As selected by Supervising Professional from the manufacturer's full range of colors and patterns produced for carpet specified.

END OF SECTION 09680

1.8.6. Section 09900 - Painting

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes surface preparation, painting, and finishing of exposed interior and exterior items and surfaces.
 - 1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Supervising Professional will select from standard colors and finishes available.
 - 1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
 - 1. Prefinished items include but are not limited to the following factory-finished components:
 - a. Architectural casework.
 - b. Metal toilet enclosures.
 - c. Finished mechanical and electrical equipment.
 - d. Light fixtures.
 - e. Distribution cabinets.
 - 2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
 - a. Ceiling plenums.
 - b. Pipe spaces.
 - c. Duct shafts.
 - 3. Finished metal surfaces include the following:
 - a. Anodized aluminum.
 - b. Stainless steel.

- c. Copper.
- 4. Operating parts include moving parts of operating equipment and the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
- 5. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- D. Related Sections include the following:
 - 1. Division 3 Section "Cast in Place Concrete" for surface preparation of exposed interior concrete finishes.
 - 2. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.
 - 3. Division 6 Section "Interior Architectural Woodwork" for shop priming interior architectural woodwork.
 - 4. Division 8 Section "Steel Doors and Frames" for shop priming steel doors and frames.
 - 6. Division 9 Section "Gypsum Board Assemblies" for surface preparation for gypsum board.

1.3 DEFINITIONS

- A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
 - 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 - 2. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.
 - 3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
 - 4. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
 - 5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

- A. Samples for initial color selection in the form of manufacturer's color charts shall be submitted to the Supervising Professional for color selection. Field samples on various surfaces to be finished may be requested by the Supervising Professional.
- B. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
- B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Manufacturer's stock number and date of manufacture.
 - 4. Contents by volume, for pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
 - 8. VOC content.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 - 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 PROJECT CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F (10 and 32 deg C).
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F (7.2 and 35 deg C).
- C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.
 - 1. Quantity: Provide one gallon of each type of stain and paint to Owner.
 - 2. Provide formulation of each paint product and color used on project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in the paint schedules.
- B. Manufacturers Names: The following manufacturers are referred to in the paint schedules by use of shortened versions of their names, which are shown in parentheses:
 - 1. Devoe & Raynolds Co. (Devoe).
 - 2. Glidden Co. (The) (Glidden).
 - 3. Benjamin Moore & Co. (Moore).
 - 4. PPG Industries, Inc. (PPG).
 - 5. Pratt & Lambert, Inc. (P & L).
 - 6. Mautz Paint Co. Industrial Division
 - 7. Sherwin-Williams Co. (S-W).

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
- C. Colors: Provide color selections made by the Supervising Professional.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
 - 1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify the Supervising Professional about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Provide barrier coats over incompatible primers or remove and reprime.
 - 2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.

- b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.
 - 3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
 - b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and backsides of wood, including chair rail, counter edge bands, and shelving.
 - c. When transparent finish is required, backprime with spar varnish.
 - d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.
 - e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
 - 4. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
 - a. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
 - 5. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
 - D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.
 - E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to

match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in the schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 - 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment with prime coat only.
 - 6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 - 7. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - 2. Omit primer on metal surfaces that have been shop primed and touchup painted.
 - 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 - 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

- C. Application Procedures: Apply paints and coatings by brush or roller according to manufacturer's written instructions.
 - 1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
 - 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.
 - 1. Items to be painted include: Piping and accessory items.
- F. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
- G. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
- H. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

3.4 CLEANING

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

3.5 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Supervising Professional.

- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.
- C. Paint plywood equipment boards in their entirety prior to the installation of equipment. Coordinate this Work with other trades.

3.6 EXTERIOR PAINT SCHEDULE

- A. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items.
 - 1. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a rust-inhibitive primer.
 - a. Primer: Rust-inhibitive metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils (0.033 mm).
 - 1) Devoe: 13101 Mirrolac Rust Penetrating Metal Primer.
 - 2) Moore: IronClad Retardo Rust-Inhibitive Paint #163.
 - 3) PPG: 6-208 Speedhide Interior/Exterior Rust Inhibitive Steel Primer.
 - 4) P & L: S 4551 Tech-Gard High Performance Rust-Inhibitor Primer.
 - 5) S-W: Kem Kromik Metal Primer B50N2/B50W1.
 - b. First and Second Coats: Full-gloss, exterior, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3.0 mils (0.076 mm).
 - 1) Devoe: 70XX Mirrolac Interior/Exterior Alkyd-Urethane Gloss Enamel.
 - 2) Moore: Impervo Enamel #133.
 - 3) PPG: 6-282 Speedhide Interior/Exterior Gloss-Oil Enamel.
 - 4) P & L: S 4500 Series Tech-Gard Maintenance Gloss Enamel.
 - 5) S-W: Industrial Enamel B-54 Series.
- B. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated (galvanized) metal surfaces:
 - 1. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a galvanized metal primer.
 - a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
 - 1) Devoe: 8502/8520 Mirrolac-WB Interior/Exterior Waterborne Flat DTM Primer and Finish.
 - 2) Moore: IronClad Galvanized Metal Latex Primer #155.

- 3) PPG: 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel.
 - 4) P & L: Z/F 1003 Suprime "3" Interior/Exterior Latex Metal Primer.
 - 5) S-W: Galvite Paint B50W3.
 - b. First and Second Coats: Full-gloss, exterior, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).
 - 1) Devoe:70XX Mirrolac Interior/Exterior Alkyd-Urethane Gloss Enamel.
 - 2) Moore:Impervo Enamel #133.
 - 3) PPG: 6-282 Speedhide Interior/Exterior Gloss-Oil Enamel.
 - 4) P & L: S 4500 Series Tech-Gard Maintenance Gloss Enamel.
 - 5) S-W: Industrial Enamel B-54 Series.
- C. Aluminum: Provide the following finish systems over exterior aluminum surfaces:
1. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a primer.
 - a. Primer: Rust-inhibitive, acrylic- or alkyd-based, metal primer, as recommended by the manufacturer for use over aluminum, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.4 mils (0.036 mm).
 - 1) Devoe:8502/8520 Mirrolac-WB Interior/Exterior Waterborne Flat DTM Primer and Finish.
 - 2) Moore:IronClad Retardo Rust-Inhibitive Paint #163.
 - 3) PPG: 90-709 Pitt-Tech Primer.
 - 4) P & L: Z/F 1003 Suprime "3" Interior/Exterior Latex Metal Primer.
 - 5) S-W: Pro-Cryl Universal Water Based Primer B66-310.
 - b. First and Second Coats: Full-gloss, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).
 - 1) Devoe:70XX Mirrolac Interior/Exterior Alkyd-Urethane Gloss Enamel.
 - 2) Moore:Impervo Enamel #133.
 - 3) PPG: 6-282 Speedhide Interior/Exterior Gloss Oil Enamel.
 - 4) P & L: S 4500 Series Tech-Gard Maintenance Gloss Enamel.
 - 5) S-W: Industrial Enamel B-54 Series.

3.7 INTERIOR PAINT SCHEDULE

- A. Concrete Masonry Units: Where scheduled, provide the following finish systems over interior concrete masonry block units:
1. Semigloss, Alkyd-Enamel Finish: 2 finish coats over an undercoat and a filled surface.

- a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 5.0 mils (0.13 mm).
 - 1) Devoe: 52902 Bloxfil 200 Interior/Exterior Latex Block Filler.
 - 2) Moore: Moorcraft Interior & Exterior Block Filler #173.
 - 3) PPG: 6-7 Speedhide Interior/Exterior Masonry Latex Block Filler.
 - 4) P & L: Z 98 Pro-Hide Plus Latex Block Filler.
 - 5) S-W: Prep-Rite Blockfiller B25W25.
 - b. Undercoat: Interior, alkyd- or latex-based, enamel undercoater, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
 - 1) Devoe: 26XX Velour Interior Alkyd Semi-Gloss Enamel.
 - 2) Moore: Moore's Alkyd Enamel Underbody #217.
 - 3) PPG: 6-855 Speedhide Interior Latex Enamel Undercoater.
 - 4) P & L: S/D 1012 Suprime "12" Interior Alkyd Wall Primer.
 - 5) S-W: Promar 200 Alkyd Semi-Gloss
 - c. Finish Coat: Odorless, semigloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils (0.038 mm).
 - 1) Devoe: 26XX Velour Interior Alkyd Semi-Gloss Enamel.
 - 2) Moore: Satin Impervo #235.
 - 3) PPG: 27 Line Wallhide Low Odor Interior Enamel Wall and Trim Semi-Gloss Oil.
 - 4) P & L: S/D 5700 Series Cellu-Tone Alkyd Satin Enamel.
 - 5) S-W: Promar 200 Alkyd Semi-Gloss
- B. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:
- 1. Low-Luster, Acrylic-Enamel Finish: 2 finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
 - 1) Devoe: 50801 Wonder-Tones Interior Vinyl Latex Primer-Sealer.
 - 2) Moore: Regal First Coat Interior Latex Primer & Underbody #216.
 - 3) PPG: 17-10 Quick-Drying Interior Latex Primer-Sealer.
 - 4) P & L: Z/F 1004 Suprime "4" Interior Latex Wall Primer.
 - 5) S-W: PrepRite 200 Interior Latex Primer
 - b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils (0.071 mm).
 - 1) Devoe: 34XX Wonder-Tones Interior Latex Eggshell Enamel.
 - 2) Moore: Moore's Regal AquaVelvet #319.

- 3) PPG: 89 Line Manor Hall Eggshell Latex Wall and Trim Enamel.
- 4) P & L: Z/F 4000 Series Accolade Interior Velvet.
- 5) S-W: ProMar 200 Interior Latex Eg-Shel B20 Series

C. Stained Woodwork: Provide the following stained finishes over, interior woodwork:

1. Alkyd-Based, Satin-Varnish Finish: 2 finish coats of an alkyd-based, clear-satin varnish over a sealer coat and an alkyd-based, interior wood stain. Wipe wood filler on open grain woods before applying stain.
 - a. Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.
 - 1) Devoe: None required.
 - 2) Moore: Benwood Paste Wood Filler #238.
 - 3) PPG: None required.
 - 4) P & L: None required.
 - 5) S-W: Sher-Wood Natural Filler.
 - b. Stain Coat: Alkyd-based, interior wood stain applied at spreading rate recommended by the manufacturer.
 - 1) Devoe: 96XX WoodWorks Alkyd Interior Stain.
 - 2) Moore: Benwood Penetrating Stain #234.
 - 3) PPG: 77-302 Rez Interior Semi-Transparent Stain.
 - 4) P & L: S-Series Tonetic Wood Stain.
 - 5) S-W: Oil Stain A-49 Series.
 - c. Sealer Coat: Clear sanding sealer applied at spreading rate recommended by the manufacturer.
 - 1) Devoe: 4900 WoodWorks Quick-Dry Clear Sealer.
 - 2) Moore: Moore's Interior Wood Finishes Quick-Dry Sanding Sealer #413.
 - 3) PPG: 77-30 Rez Interior Quick-Drying Sealer and Finish.
 - 4) P & L: H-40 Sanding Sealer.
 - 5) S-W: Wood Classics FastDry Sanding Sealer B26V43.
 - d. First and Second Finish Coats: Alkyd-based or polyurethane varnish, as recommended by the manufacturer, applied at spreading rate recommended by the manufacturer.
 - 1) Devoe: 4600 WoodWorks Alkyd Satin Varnish.
 - 2) Moore: Benwood Satin Finish Varnish #404.
 - 3) PPG: 77-7 Rez Varnish, Interior Satin Oil Clear.
 - 4) P & L: H24 38 Clear Finish Gloss.
 - 5) S-W: FastDry Oil Base Varnish, Gloss A66-300.

D. Ferrous Metal and Plywood Equipment Boards: Provide the following finish systems over ferrous metal:

1. Full-Gloss, Acrylic-Enamel Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate,

applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils (0.038 mm).

- 1) Devoe: 13101 Mirrolac Rust Penetrating Metal Primer.
 - 2) Moore: IronClad Retardo Rust-Inhibitive Paint #163.
 - 3) PPG: 6-208 Speedhide Interior/Exterior Rust Inhibitive Steel Primer.
 - 4) P & L: S 4551 Tech-Gard High Performance Rust Inhibitor Primer.
 - 5) S-W: Kem Kromik Metal Primer B50N2/B50W1.
- b. First and Second Coats: Full-gloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.5 mils (0.064 mm).
- 1) Devoe: 84XX Mirrolac-WB Interior-Exterior Waterborne High Gloss Enamel.
 - 2) Moore: Impervex Enamel #309.
 - 3) PPG: 51 Line Brilliant Reflections Interior/Exterior Latex Gloss Enamel.
 - 4) P & L: Z/F 4400 Series Accolade Interior High Gloss.
 - 5) S-W: ProMar 200 Interior Latex Gloss Enamel B21W201.

- E. Zinc-Coated Metal: Provide the following finish systems over zinc-coated metal:
1. Full-Gloss, Acrylic-Enamel Finish: 2 coats over a primer.
 - a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
 - 1) Devoe: 13201 Mirrolac Galvanized Metal Primer.
 - 2) Moore: IronClad Galvanized Metal Latex Primer #155.
 - 3) PPG: 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel.
 - 4) P & L: Z/F 1003 Suprime "3" Interior/Exterior Latex Metal Primer.
 - 5) S-W: Galvite Paint B50W3.
 - b. First and Second Coats: Full-gloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.5 mils (0.064 mm).
 - 1) Devoe: 84XX Mirrolac-WB Interior-Exterior Waterborne High Gloss Enamel.
 - 2) Moore: Impervex Enamel #309.
 - 3) PPG: 51 Line Brilliant Reflections Interior/Exterior Latex Gloss Enamel.
 - 4) P & L: Z/F 4400 Series Accolade Interior High Gloss.
 - 5) S-W: Industrial Enamel B54YZ37.
 2. Color: For interior piperrails, handrails, guardrails, and steel tube curbs at inspection pits, paint safety yellow.

F. Interior Wood Decks Exposed To View:

1. Dry Fall Flat Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, wood primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.0 mils.
 - 1) S-W: Prep Rite Classic B28W101.
 - b. First and Second Coats: Dry fall Flat white modified alkyd paint for interior use, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 4.0 mils.
 - 1) S-W: Waterborne Acrylic Eg-Shel Dry fall B42W2.

END OF SECTION 09900

1.9. Division 10 – Specialties

1.9.1. Section 10200 – Louvers and Vents

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 fixed, extruded-aluminum louvers.
- B. Related Sections include the following:
 - 1. Division 7 Section "Joint Sealants" for sealants installed in perimeter joints between louver frames and adjoining construction.
 - 2. Division 15 Sections for louvers that are a part of mechanical equipment.
 - 3. Division 16 Sections for electrical power connections for motor-operated adjustable metal louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.
 - 1. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft., acting inward or outward.

- B. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, 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 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- C. Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- D. Airborne Sound Transmission Loss: Provide acoustical louvers complying with airborne sound transmission loss ratings indicated, as demonstrated by testing manufacturer's stock units identical to those specified, except for length and width according to ASTM E 90.

1.5 SUBMITTALS

- A. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.
- B. Samples for Initial Selection: For units with factory-applied color finishes.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2, "Structural Welding Code--Aluminum."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
- C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- D. UL and NEMA Compliance: Provide motors and related components for motor-operated adjustable louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

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. Louvers:
 - a. Airline Products Co.
 - b. Airolite Company (The).
 - c. Carnes Company, Inc.
 - d. Greenheck.
 - e. Or approved equal.
- B. In other Part 2 articles where products are listed, the following requirements apply for product selection:
 - 1. Basis-of-Design Product: The design for each louver is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy 6063-T5 or T-52.
- B. Fasteners: Of 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.
- C. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION, GENERAL

- A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- D. Include supports, anchorages, and accessories required for complete assembly.
- E. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.
 - 1. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
- F. Where indicated, provide subsills made of same material as louvers or extended sills for recessed louvers.
- G. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.4 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal Sight proof, Drainable blade Louver (OAL-1, EAL-1 on Mechanical drawings).
 - 1. Basis-of-Design Product: ELF375DX by Ruskin or a comparable product of one of the following:
 - a. Airolite.
 - b. Greenheck.
 - 2. Louver Depth: As indicated on mechanical drawings.
 - 3. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.080 inch (2.0 mm) for blades and 0.080 inch (2.0 mm) for frames.

4. Refer to Louver Schedule in the HVAC Drawings, and to exterior elevations for placement within masonry coursing.
5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.5 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
 1. Screen Location for Fixed Louvers: Interior face.
 2. Screening Type: Insect screening.
- B. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 1. Metal: Same kind and form of metal as indicated for louver to which screens are attached
 2. Finish: Same finish as louver frames to which louver screens are attached.
 3. Type: Rewirable frames with a driven spline or insert for securing screen mesh.
- C. Louver Screening for Aluminum Louvers:
 1. Insect Screening: Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.

2.6 BLANK-OFF PANELS (If Required)

- A. Insulated, Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets.
 1. Thickness: 2 inches (50 mm).
 2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch (0.8-mm) nominal thickness.
 3. Insulating Core: Unfaced mineral-fiber rigid insulation board.
 4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch (2.0-mm) nominal thickness, with corners mitered and with same finish as panels.
 5. Seal perimeter joints between panel faces and louver frames with 1/8-by-1-inch (3.2-by-25-mm) PVC compression gaskets.
 6. Panel Finish: Same finish applied to louvers.
 7. Attach blank-off panels to back of louver frames stainless-steel, sheet metal screws.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish louvers after assembly.

2.8 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
- B. High-Performance Organic-Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Fluoropolymer Three-Coat Coating System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
 - a. Color and Gloss: As selected by Supervising Professional from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.

- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. 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.
- F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
- B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
- C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Supervising Professional, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 10200

1.9.2. Section 10418 - Map Cases

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Glass enclosed, locking map cases.

1.3 SUBMITTALS

- A. Submit shop drawings, technical data sheets and schedules.
- B. Submit sample of specified color finish for approval.
- C. Make submittals in accordance with Section 01300.

1.3 DELIVERY & STORAGE

- A. Ship materials including attachment devices carefully packaged to prevent surface damage. Include shop drawings to insure correct installation and arrangement of all materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Manufacturers of Map Cases:
 - a. Aarco Products, Inc.
 - b. Nelson-Harkins Industries
 - c. Apco

2.1 MAP CASE

- A. Provide custom color acrylic polyurethane finish on all exposed framing in color to match aluminum curtainwall/windows.
- B. Doors shall be constructed so as not to rack and so that the glass is not used to keep door square and in line. Corners shall be braced by means of hidden aluminum angles or other like methods. If welding is used, there shall be no visible welds. No screws shall be visible when door is closed. All screws used throughout the case shall be plated with cadmium or like material.
- C. Locks shall be of tumbler type and shall be keyed alike. Locks which can be opened with any object except key provided will not be acceptable.
- D. Glass shall be minimum 1/4" clear tempered plate.
- E. Continuous anodized aluminum piano hinge with stainless steel pin shall be used.
- F. Frame shall be constructed so as to have a continuous back up member behind door.
- G. Invisible venting shall be provided to prevent condensation. Hinged door cases shall be made dust tight by means of felt or neoprene gasketing.
- H. Frames shall be assembled by means of invisible aluminum angles, gussets or like material. No knocked down or unassembled cases will be accepted. Backs shall be exterior plywood, SIS grade. If welding is used, there shall be no visible welds.
- I. Units shall have double leaf doors.
- J. Provide cork backgrounds of the bulletin board, self-sealing grade. Bulletin boards shall have tan color.
- K. Cases shall be recess mounted with concealed fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install map cases in accordance with shop drawings and manufacturer's recommendations.

1.9.3. Section 10425 - Signs

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of signs:
 - 1. Panel signs.
 - 2. Dimensional letters and numbers.
 - 3. Die-cut vinyl lettering and graphics.
 - 4. Cast metal plaques.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 15 Section "Mechanical Identification" for labels, tags, and nameplates for mechanical equipment.
 - 2. Division 16 Section "Electrical Identification" for labels, tags, and nameplates for electrical equipment.
 - 3. Division 16 Section "Interior Lighting" for illuminated exit signs.

1.3 SUBMITTALS

- A. Product data for each type of sign specified, including details of construction relative to materials, dimensions of individual components, profiles, finishes, and lettering/pictogram layout.
- B. Shop drawings showing fabrication and erection of signs. Include plans, elevations, and large scale sections of typical members and other components. Show anchors, grounds, layout, reinforcement, accessories, and installation details.
- C. Samples: Provide the following samples for initial selection of color, pattern and surface texture as required and for verification of compliance with requirements indicated.
 - 1. Cast Acrylic Sheet and Plastic Laminate: Manufacturer's color charts consisting of actual sections of material including the full range of colors available for each material required.
 - 2. Dimensional Letters and Numbers: Full size sample for confirmation indicating font, size, style, and finish.

- D. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: For each separate sign type required, obtain signs from one source of a single manufacturer.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Manufacturers of Panel Signs:
 - a. ABC Architectural Signing System.
 - b. Andco Industries Corp.
 - c. ASI Sign Systems, Inc.
 - d. Best Manufacturing Company.
 - e. Charlestown Industries, Inc.
 - f. Environmental Graphic Systems, Inc.
 - g. InPro Corporation
 - h. Poblocki & Sons, Inc.
 - i. The Supersine Company.
 - j. Or approved equal
 - 2. Manufacturers of Dimensional Letters and Cast Metal Plaques:
 - a. Andco Industries Corp.
 - b. A.R.K. Ramos Manufacturing Company, Inc.
 - c. ASI Sign Systems, Inc.
 - d. Gemini, Inc.
 - e. Matthews International Corp.
 - f. Metal Arts
 - g. Metallic Arts, Inc.
 - h. The Southwell Company
 - i. Or approved equal.

2.2 MATERIALS - PANEL SIGNS

- A. Cast Acrylic Sheet: Provide cast (not extruded or continuous cast) methyl methacrylate monomer plastic sheet, in sizes and thicknesses indicated, with a minimum flexural strength of 16,000 psi when tested according to ASTM D 790, with a minimum allowable continuous service temperature of 176 deg F (80 deg C), and of the following general types:
- B. Colored Coatings for Acrylic Plastic Sheet: Use colored coatings, including inks and paints for copy and background colors, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are nonfading for the application intended.

2.3 MATERIALS - DIMENSIONAL LETTERS

- A. Aluminum Castings: Provide aluminum castings of alloy and temper recommended by the sign manufacturer for the casting process used and for the use and finish indicated.
- B. Fasteners: Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.
- C. Anchors and Inserts: Use nonferrous metal or hot-dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.4 PANEL SIGNS

- A. Unframed Panel Signs: Fabricate signs with edges mechanically and smoothly finished to conform with the following requirements:
 - 1. Edge Condition: Square cut.
 - 2. Corner Condition: Square corners.
- B. Graphic Content and Style: Provide sign copy that complies with the requirements indicated for size, style, spacing, content, position, material, finishes, and colors of letters, numbers, and other graphic devices. See Sign Schedule at the end of this section.
 - 1. Character Proportion. Letters and numbers on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10.
 - 2. Character Height. Characters and numbers on signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case X. Lower case characters are permitted.

3. Raised and Brailled Characters and Pictorial Symbol Signs (Pictograms). Letters and numerals shall be raised 1/32 in., upper case, sans serif or simple serif type and shall be accompanied with Grade 2 Braille. Raised characters shall be at least 5/8 in. (16 mm) high, but no higher than 2 in. (50 mm). Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be 6 in. (152 mm) minimum in height.
 4. Finish and Contrast. The characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background -- either light characters on a dark background or dark characters on a light background.
 5. Mounting Location and Height. Where permanent identification is provided for rooms and spaces, signs shall be installed on the wall adjacent to the latch side of the door. Where there is no wall space to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall. Mounting height shall be 60 in. (1525 mm) above the finish floor to the centerline of the sign. Mounting location for such signage shall be so that a person may approach within 3 in. (76 mm) of signage without encountering protruding objects or standing within the swing of a door.
- C. Raised Copy: Machine-cut copy characters from matte-finished opaque acrylic sheet and chemically weld onto the acrylic sheet forming sign panel face. Produce precisely formed characters with square cut edges free from burrs and cut marks.
1. Panel Material: Matte-finished opaque acrylic sheet.
 2. Raised Copy Thickness: Not less than 1/32 inch.

2.5 DIMENSIONAL LETTERS AND NUMBERS

- A. Cast Letters and Numbers: Form individual letters and numbers by casting. Produce characters with smooth, flat faces, sharp corners, and precisely formed lines and profiles, free from pits, scale, sand holes, or other defects. Cast lugs into the back of characters and tap to receive threaded mounting studs. Comply with requirements indicated for finish, style, and size.
- B. Aluminum Finish: Baked enamel finish, reflective paint finish where indicated.
- C. Color: To be selected by Supervising Professional from manufacturer's full range of colors.
- D. Sizes: Provide letters and numbers as indicated.
- E. Style (Font): To be selected by supervising professional from manufacturers full range of products.

- F. Projected Mounting: Spaced 1/2 inch from wall surface.

2.6 DIE-CUT VINYL LETTERING AND GRAPHICS

- A. Vinyl Film: Translucent, non-reflective vinyl film, 0.0035-inch min. thickness, with pressure-sensitive adhesive backing, suitable for exterior applications.
- B. State Patrol Graphic: Logo illustrating design will be provided by WisDOT. Contact Bob Spoerl at (608) 266-8665 for more information. Approximate size: 18-inches x 18-inches.
- C. Department of Transportation Graphic: Logo illustrating design will be provided by WisDOT. Contact Bob Spoerl at (608) 266-8665 for more information. Approximate size: 18-inches x 18-inches.

2.7 CAST METAL PLAQUES

- A. Basis-of-Design Product: Metal Arts Cast Metal Plaques.
 - 1. Material: Bronze.
 - 2. Size: 16" x 24" (to be verified).
 - 3. Background: Dark Anodized, Pebbled Textured.
 - 4. Border Style: Single Line Edge.
 - 5. Mounting: Concealed Mounting on masonry substrate.
 - 6. Letter style: Palatino, raised letters.
 - 7. Sign Text: Concept illustrated below, final size and content to be verified.
 - 8. Location: Coordinate mounting location in field with Supervising professional.

Madison Safety & Weight Enforcement Facility No. 16
Wisconsin DOT & State Patrol

Quote about motor carrier unit's mission (to be verified).

Dedicated: Month, Date, Year (to be verified).

Governor:
(to be verified)

Secretary of Transportation:
(to be verified)

Others to Recognize:
(to be verified)

Architect: Vierbicher Associates, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Locate sign units and accessories as scheduled using mounting methods of the type described and in compliance with the manufacturer's instructions.
 - 1. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.
- B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using the methods indicated below:
 - 1. Vinyl-Tape Mounting: Use double-sided foam tape to mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
- C. Dimensional Letters and Numbers: Mount letters and numbers using standards fastening methods recommended by the manufacturer for letter form, type of

mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish letter spacing and to locate holes for fasteners.

3.2 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

3.3 PANEL SIGN SCHEDULE

- A. All signs below are 8 inches by 8 inches. Provide a sign for each room as scheduled below:

LOCATION	GRAPHIC/TEXT
MEN	Male Pictogram w/ Universal Accessibility Symbol
WOMEN	Female Pictogram w/ Universal Accessibility Symbol
STAFF TOILET	UNISEX STAFF TOILET Including Pictogram w/ Universal Accessibility Symbol
ENTRY	NO LOITERING

END OF SECTION 10425

1.9.4. Section 10505 - Locker Benches

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 locker benches.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product specified.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
- C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
- D. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals specified in Division 1.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver products until spaces to receive them are clean, dry, and ready for installation. Protect products from damage during delivery, handling, storage, and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Locker Benches: Where benches are indicated on the drawings, provide products complying with the following:
 - a. Products: Available products include the following:
 - 1) Republic

- 2) Hadrain
- 3) Penco
- 4) Lyon
- 5) Or approved equal.
- b. Material: Hardwood
- c. Base: Steel Pedestal, Painted with color selected by Supervising Professional.
- d. Size: 12-inch wide x 18-inch high x 72-inch long
- e. Finish: 2 coats of acrylic finish

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for suitable conditions where products are to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Anchor locker benches to floors Uniformly space pedestals not more than 72 inches (1830 mm) apart, and securely fasten to bench top and anchor to floor.

3.3 CLEANING, AND PROTECTION

- A. Clean exposed exterior surfaces. Protect products from damage, abuse, dust, dirt, stain, or paint. Touch up marred finishes, or replace units that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10505

1.9.5. Section 10522 - Fire Extinguishers, Cabinets, & Accessories

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Fire extinguishers.
 - 2. Fire extinguisher cabinets.
 - 3. Fire extinguisher mounting brackets.

1.3 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for cabinets include rough-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type and materials, trim style, door construction, panel style, and materials.
- C. Samples for initial selection purposes in the form of manufacturer's color charts consisting of actual units or sections of units showing full range of colors, textures, and patterns available for each type of cabinet finish indicated or exposed to view.
- D. Operating and Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Obtain extinguishers and cabinets from one source from a single manufacturer.
- B. Coordination: Verify that cabinets are sized to accommodate type and capacity of extinguishers indicated.
- C. UL-Listed Products: Fire extinguishers shall be UL listed with UL listing mark for type, rating, and classification of extinguisher.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. J.L. Industries, Larsen's Mfg. Co. Walter Kidde, or approved equal.

2.2 FIRE EXTINGUISHERS

- A. General: Provide fire extinguishers for each cabinet and other locations indicated, in colors and finishes selected by Supervising Professional from manufacturer's standard, that comply with authorities having jurisdiction.
- B. Multipurpose Dry Chemical Type: UL Rated 4A-60 BC, 10 lb. nominal capacity.
- C. Extinguisher Finish: Steel, enamel, red color.

2.3 MOUNTING BRACKETS

- A. Brackets: Designed to prevent accidentally dislodging extinguisher, of sizes required for type and capacity of extinguisher indicated, in plated finish.
 - 1. Wall Mounted: Provide brackets for extinguishers not located in cabinets.
 - 2. Cabinet Type: Provide brackets for extinguishers located in cabinets.

2.4 CABINETS

- A. Construction: Manufacturer's standard box, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind smooth. Miter and weld perimeter door frames.
- B. Cabinet Type: Suitable for containing the following:
 - 1. Fire extinguisher.
 - 2. Cabinet must meet A.D.A.A.G. and ANSI 117.1 criteria.
- C. Cabinet Metal: Aluminum sheets, anodized same as door and trim.
- D. Cabinet Mounting: Suitable for the following mounting conditions:
 - 1. Semi-recessed: Cabinet box semi-recessed in walls of sufficient depth to suit style of trim indicated.
- E. Trim Style: Fabricate trim in one piece with corners mitered, welded, and ground smooth.

1. Exposed Trim: One piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 - a. Flat Trim: 1/4 inch to 5/16 inch backbend depth.
 - b. Trim Metal: Extruded aluminum shapes.
 2. Door Material and Construction: Manufacturer's standard door construction, of material indicated, coordinated with cabinet types and trim styles selected.
 - a. Extruded aluminum.
 3. Door Glazing: Fully tempered float glass complying with ASTM C 1048, Condition A, Type I, Quality q3, Kind FT, Class as follows:
 - a. Class 1 (clear).
- F. Identify fire extinguisher in cabinet with FIRE EXTINGUISHER lettering applied to door. Provide lettering.
1. Application Process: Silk screen.
- G. Identify bracket-mounted extinguishers with FIRE EXTINGUISHER on a wall-mounted sign, located minimum of 80 inches above the finish floor, directly above the extinguisher. Use letter size, style, and location to comply with authorities having jurisdiction for letter style, color, size, spacing, and location.
- H. Door Style: Manufacturer's standard design.
1. Full-Glass Panel with frame: Float glass, fully tempered, 1/8-inch thick.
- I. Door Hardware: Provide manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated. Provide either lever handle with cam-action latch, or exposed or concealed door pull and friction latch. Provide concealed or continuous-type hinge permitting door to open 180 deg.

2.5 FINISHES FOR CABINETS, GENERAL

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying temporary strippable protective covering prior to shipping.

2.6 ALUMINUM CABINET FINISHES

- A. Class I Color Anodic Finish: AA-M12C22A42/A44.
 1. Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating complying with AAMA 606.1 or AAMA 608.1.

- a. Color: As selected by Supervising Professional from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for thickness and framing for cabinets to verify cabinet depth and mounting prior to cabinet installation. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Follow manufacturer's printed instructions for installation.
- B. Prepare recesses in walls for cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.
- C. Install in locations indicated, and mount at height to position center of door handle at 48" above the floor. Fasten mounting brackets and cabinets to structure, square and plumb.

END OF SECTION 10522

1.9.6. Section 10800 - Toilet and Bath Accessories

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 toilet and bath accessory items as scheduled.

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for each toilet accessory item specified, including construction details relative to materials, dimensions, gages, profiles, mounting method, specified options, and finishes.
- C. Schedule indicating types, quantities, sizes, and installation locations (by room) for each toilet accessory item to be provided for project.
- D. Maintenance data for each product specified, to include in Operating and Maintenance Manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise acceptable to Supervising Professional.

1.5 PROJECT CONDITIONS

- A. Coordination: Coordinate accessory locations, installation, and sequencing with other work to avoid interference with and ensure proper installation, operation, adjustment, cleaning, and servicing of toilet accessory items.

1.6 WARRANTY

- A. Warranty: Submit a written warranty executed by mirror manufacturer, agreeing to replace any mirrors that develop visible silver spoilage defects within warranty period.
- B. Warranty Period: 15 years from date of Substantial Completion.
- C. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering toilet accessories that may be incorporated in the Work include, but are not limited to, the following:
 - 1. A & J Washroom Accessories.
 - 2. American Specialties, Inc.
 - 3. Bobrick Washroom Equipment, Inc.
 - 4. Bradley Corporation.
 - 5. McKinney/Parker.
 - 6. Doug Mockett & Company, Inc.

2.2 MATERIALS, GENERAL

- A. Stainless Steel: AISI Type 302/304, with satin stainless finish, 0.034-inch (22-gage) minimum thickness.
- B. Galvanized Steel Sheet: ASTM A 527, G60.
- C. Chromium Plating: Nickel and chromium electro-deposited on base metal, ASTM B 456, Type SC 2.
- D. Mirror Glass: Nominal 6.0-mm (0.23-inch) thick, conforming to ASTM C 1036, Type I, Class 1, Quality q2, and with silvering, electro-plated copper coating, and protective organic coating.

2.3 PRODUCTS

- A. Clothes Hook: Provide (7) at Troop Room 108 and (2) at Staff Toilet Room 107. Mockett HK4A, A&J Washroom Accessories, or approved equal.

- B. Toilet Paper Dispenser: Provide at each toilet shown on the plans. Bobrick Model B-4288, American Specialties, Inc, A&J Washroom Accessories, or approved equal.
- C. Lavatory Mounted Soap Dispenser: At each lavatory shown in women 101 and men 102, Bobrick Model B-8226 (6-inch spout length) American Specialties, Inc, A&J Washroom Accessories, or approved equal.
- D. Surface Mounted Soap Dispenser: At the lavatory in staff toilet room 107, provide Bobrick Model B-4112, American Specialties, Inc, A&J Washroom Accessories, or approved equal.
- E. Shelf: At the lavatory in staff toilet room 107, provide Bobrick Model B-298 in single piece, 24-inch length, American Specialties, Inc, A&J Washroom Accessories, or approved equal.
- F. Paper Towel/Trash: Provide at each toilet room shown on the plans. Bobrick Model B-396034, American Specialties, Inc, A&J Washroom Accessories, or approved equal.
- G. Mirrors: Provide at each toilet room shown on the plans. Bobrick Model B-290, American Specialties, Inc, A&J Washroom Accessories, or approved equal. (24"x48")
- H. Grab Bars: Provide at each toilet room shown on the plans. Bobrick Model B-6206, American Specialties, Inc, A&J Washroom Accessories, or approved equal. See plans for length.
- I. Sanitary Napkin Disposal: Provide at Women's toilet room. At recessed locations, provide Bobrick Model B-4353, American Specialties, Inc, A&J Washroom Accessories, or approved equal. At partition-mounted locations, provide Bobrick Model B-4354, American Specialties, Inc, A&J Washroom Accessories, or approved equal.

2.4 FABRICATION

- A. General: Only a maximum 1-1/2-inch-diameter, unobtrusive stamped manufacturer logo, as approved by Supervising Professional, is permitted on exposed face of toilet or bath accessory units. On either interior surface not exposed to view or back surface, provide additional identification by either a printed, waterproof label or a stamped nameplate, indicating manufacturer's name and product model number.
- B. Surface-Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hang doors or

access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.

- C. Recessed Toilet Accessories, General: Except where otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors or access panels with full-length, stainless steel piano hinge. Provide anchorage that is fully concealed when unit is closed.
- D. Framed Mirror Units, General: Fabricate frames for glass mirror units to accommodate wood, felt, plastic, or other glass edge protection material. Provide mirror backing and support system that will permit rigid, tamperproof glass installation and prevent moisture accumulation, as follows:
 - 1. Provide galvanized-steel backing sheet, not less than 0.034 inch (22 gage) and full mirror size, with non-absorptive filler material. Corrugated cardboard is not an acceptable filler material.
- E. Mirror Unit Hangers: Provide system for mounting mirror units that will permit rigid, tamperproof, and theft proof installation, meeting one of the requirements listed below:
 - 1. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - 2. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
- F. Keys: Provide universal keys for access to toilet accessory units requiring internal access for servicing, resupply, etc. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install toilet accessory units according to manufacturers' instructions, using fasteners appropriate to substrate as recommended by unit manufacturer. Install units plumb and level, firmly anchored in locations and at heights indicated.
- B. Secure mirrors to walls in concealed, tamperproof manner with special hangers, toggle bolts, or screws. Set units plumb, level, and square at locations indicated, according to manufacturer's instructions for type of substrate involved.
- C. Install grab bars to withstand a downward load of at least 250 lbf, complying with ASTM F 446.

- D. Install lavatory mounted soap dispensers so end of spout extends over inner edge of bowl. Lavatory-mounted soap dispenser shall operate with less than five pounds of force when completely filled.

3.2 ADJUSTING AND CLEANING

- A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.
- B. Clean and polish all exposed surfaces strictly according to manufacturer's recommendations after removing temporary labels and protective coatings.

END OF SECTION 10800

1.10. Division 11 – Equipment

1.10.1. Section 11100 – Suspended TV Monitor Frame

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. TV Monitor Ceiling Mounted Frame.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 5 sections for structural supports.
 - 2. Division 6 sections for blocking.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Keep products under cover and dry. Protect from weather and contact with damp or wet surfaces.

PART 2 - PRODUCTS

2.1 TV CEILING MOUNTED FRAME

- A. Basis of Design Product: The design is based on the product named. Subject to compliance with the requirements, provide either the named product or a comparable product by the named product or the other manufacturers listed in this section:
 - 1. Product: Model QLC-1622 – Quick Link Ceiling Mount Frame
 - 2. Manufacturer: Da-Lite.
 - 3. Mount: The mount shall be a fabricated mild steel design and consist of a suspended ceiling plate, sliding coupling, Quick Link pivot assembly, adjustable frame assembly, and center support tray. The suspended ceiling plate shall be a 14-gauge formed plate welded to a Unistrut™ channel.
 - a. The sliding coupling shall be a 1-1/2" NPT steel half pipe coupling MIG welded onto an 11-gauge rectangular plate with guides that fit into a Unistrut™ channel.

- b. The Quick Link pivot assembly shall be a MIG welded assembly fabricated from 3/8" thick bar, 1-1/2" diameter rod, 5/8" diameter grade 5 bolt, 5/8" nut, 5/8" vibration-resistant lock washer, 1/4" thick washer, and 1-1/2" NPT steel half pipe coupler. It shall connect to the adjustable frame assembly and allow it to swivel 360° and tilt forward 0° through 30°.
- c. The adjustable frame assembly shall consist of one 11-gauge hanger and five formed interconnecting 14-gauge channels.
- d. The 14-gauge center support tray shall have a minimum 1/2" formed lip to restrict monitor travel and be perforated for attaching the TV/monitor.
- e. Mount packages shall safely hold a 19" inch diagonal screen TV/monitor to building structure with 3/8" diameter all-thread. Mount assemblies shall have a commercial powder coat black finish whereas the suspended ceiling plate shall have a powder coat white finish.
- f. Contractor shall provide all hardware as required for a complete installation.

- B. Other Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work included but are not limited to:
 - 1. Bret Ford.
 - 2. Lucasey.
 - 3. Peerless.

PART 3 - EXECUTION

3.1 INSTALLATION, CLEANING AND ADJUSTING

- A. Install per manufacturer's recommendations. Clean and adjust all components for fully operational assembly. Protect work in place until final completion is reached.

END OF SECTION 11100

1.10.2. Section 11132 – Projection Screens

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Front-projection screens.
- B. Related Sections include the following:
 - 1. Division 6 Section "Miscellaneous Rough Carpentry " for wood blocking and support at for screen installation.

1.3 SUBMITTALS

- A. Product Data: For each type of screen indicated.
- B. Shop Drawings: Show layouts and types of projection screens. Include the following:
 - 1. Location of screen centerline relative to ends of screen case.
 - 2. Location of seams in viewing surfaces.
 - 3. Drop length.
 - 4. Connections to supporting structure for pendant- and recess-mounted screens.
 - 5. Anchorage details.
 - 6. Details of juncture of exposed surfaces with adjacent finishes.
 - 7. Frame details.
 - 8. Accessories.
- C. Samples for Initial Selection: For finishes of surface-mounted screen cases.
- D. Maintenance Data: For projection screens to include in maintenance manuals.

1.4 DELIVERY, STORAGE & HANDLING

- A. Do not deliver projection screens until building is enclosed and other construction within spaces where screens will be installed is substantially complete and ready for screen installation.

1.5 COORDINATION

- A. Coordinate layout and installation of projection screens with adjacent construction, including ceiling framing, light fixtures, HVAC equipment, and partitions.

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. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 FRONT PROJECTION SCREENS

- A. Manually Operated Screens, General: Manufacturer's standard spring-roller-operated units, consisting of case, screen, mounting accessories, and other components necessary for a complete installation.
 - 1. Screen Mounting: Top edge securely anchored to a 3-inch- (75-mm-) diameter, rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle and pull attached to slat by screws.
- B. Surface-Mounted, Metal Encased, Manually Operated Screens: Units designed and fabricated for surface mounting on wall or ceiling, fabricated from formed steel sheet not less than 0.027 inch (0.7 mm) thick or aluminum extrusions; with flat back design and vinyl covering or baked-enamel finish. Provide end caps and universal mounting brackets, finished to match end caps.
 - 1. Available Products:
 - a. Bretford Manufacturing, Inc.
 - b. Da-Lite Screen Co., Inc.; Model C, ceiling hanging.
 - c. Draper Inc.
 - d. Stewart Filmscreen Corporation; Luxus Communicator.
- C. Screen Material and Viewing Surface:
 - 1. Multipurpose Reflective Viewing Surface: Peak gain of 1.8 to 2.0, and half-gain angle of at least 25 degrees.
 - 2. Mildew Resistance: Rating of 0 or 1 when tested according to ASTM G 21.
 - 3. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
 - 4. Seamless Construction: Provide screens, in sizes indicated, without seams.

5. Edge Treatment: Black masking borders.
 6. Provide extra drop length of 24-inches to comply with the following requirements for fabric color and location of drop length:
 - a. Color: Same as viewing surface.
 - b. Location: At top of screen.
 7. Size of Viewing Surface: 84 by 84 inches (2133 by 2133 mm).
- D. Accessories:
1. Pull Rod: Provide manufacturer's standard pull rod to reach pull bail on screen. Minimum length 38 inches.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install projection screens at locations indicated to comply with screen manufacturer's written instructions.

END OF SECTION 11132

1.10.3. Section 11900 – Protective Canvas Cover

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Manually operated, horizontal protective canvas cover over exterior stair.

1.3 SUBMITTALS

- A. Product Data: For each type of material specified.
- B. Shop Drawings: Show layouts and details to illustrate assembly and operation. Include the following:
 - 1. Plans, sections, details, and elevations.
 - 2. Drainage details.
 - 3. Anchorage details.
 - 4. Frame details.
 - 5. Accessories for locking.
- C. Samples for Initial Selection: For finishes of cover and accessories.
- D. Maintenance and Operation Data: For protective cover to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate layout and installation of protective cover with adjacent construction, including wall framing, stair construction, railings, and light fixtures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

1. Custom Cover Design by Baraboo Tent and Awning, Baraboo, WI; Gallagher Tent and Awning, Madison, WI; Northrup Awning Company, Janesville, WI; or approved equal.

2.2 HORIZONTAL PROTECTIVE COVER

- A. Manually Operated Cover, General: provide manufacturer's standard mounting accessories, and other components necessary for a complete installation.
 1. Drainage: Provide sloped cover assembly for positive drainage, without obstructing occupant's clear view out of the building.
- B. Cover: Provide industrial strength, flame retardant vinyl, minimum 17-ounce weight.
 1. Available products:
 - a. Ferrari 502, by Astron Company.
 - b. BFT by John Boyle Company.
- C. Support Framing: Provide manufacturer's welded aluminum tube frame with steel supports, designed to withstand structural loads anticipated for this application. Support framing design and structural engineering is the responsibility of the fabricator.
- D. Surface-Mounted Tracks and Accessories: Units designed and fabricated for surface mounting on masonry and concrete wall substrates, fabricated from clear anodized aluminum extrusions. Tracks and mounting accessories shall permit manual removal of a 15 foot long section of the cover to access the scale tunnel. The remaining portion of the cover may be fixed. When access is not needed, cover shall be secured to prevent the build up of snow, ice, and water at the stair. Provide a jamb-mounted locking device at the end of the cover to secure it and limit unauthorized access.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install protective cover at locations indicated to comply with manufacturer's written instructions.

END OF SECTION 11900

1.11. Division 12 – Furnishings

1.11.1. Section 12485 – Foot Grilles

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes recessed foot grilles and frames.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for concrete work, including forming, placing, and finishing concrete floor slabs, and grouting frames into recesses.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide foot grilles and frames capable of withstanding and supporting a uniform load of 200 lbf/sq. ft. without exceeding the allowable design working stress of the materials involved, including anchors and connections.

1.4 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of foot grille and frame.
- B. Shop Drawings: Show fabrication, assembly, joint locations, installation details, layout, plans, elevations, full-scale sections, details of patterns or designs, anchors, and accessories for foot grilles and frames.
- C. Samples for Initial Selection: For each product requiring finish and color selections.
- D. Maintenance Data: For cleaning and maintaining foot grilles. Include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain foot grilles and frames through one source from a single manufacturer.
- B. Accessibility Requirements: In addition to requirements of authorities having jurisdiction, provide installed foot grilles that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify blocked-out openings in floors by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.7 COORDINATION

- A. Coordinate size and location of oversized recesses in concrete work to receive foot grilles and frames. Defer frame installations until building enclosure is completed and related interior finish work is in progress. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

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. Construction Specialties, Inc., Pedigrid, Reese, or approved equal.

2.2 MATERIALS

- A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with A60 (ZF180) zinc-iron-alloy (galvannealed) coating or G60 (Z180) mill-phosphatized zinc coating; stretcher-leveled standard of flatness; with minimum thickness indicated representing specified thickness according to ASTM A 924/A 924M.
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.

- C. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of alloy 5005-H15.
- D. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6061-T6 or alloy 6063-T5, T6, or T52 as standard with manufacturer. Coat surface of frame in contact with cementitious materials with manufacturer's standard protective coating.
- E. Extruded Architectural Bronze: ASTM B 455, alloy No. C38500.
- F. Stainless-Steel Angles: ASTM A 276 or ASTM A 479/A 479M, corrosion resistant, Type 304.

2.3 FOOT GRILLES

- A. Provide 4-foot x 3-foot sized foot grille, located as illustrated on the drawings. Foot grille shall be provided with a level base frame. Rail color shall be selected by the Supervising Professional from the manufacturers full range of colors and materials. Tread inserts shall be heavy-duty carpet and selected by the Supervising Professional from the manufacturers full range.

2.4 FABRICATION

- A. Shop fabricate foot grilles to greatest extent possible in sizes as indicated. If not otherwise indicated, provide each grille as a single unit; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in grilles are necessary, space symmetrically and away from normal traffic lanes.
- B. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, floor conditions, and floor recesses for compliance with requirements for location, size, minimum recess depth, and other conditions affecting installation of foot grilles and frames.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install recessed foot grilles and frames to comply with manufacturer's written instructions at locations indicated and with top of foot grilles and frames in relationship to one another and to adjoining finished flooring as recommended by manufacturer. Set foot grille tops at height for most effective cleaning action. Coordinate top of foot grille surfaces with doors that swing across grilles to provide clearance under door.

3.3 PROTECTION

- A. After completing frame installations, provide temporary filler of plywood or fiberboard in foot grille recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 12485

1.11.2. Section 12491 – Horizontal Louver Blinds

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of venetian blinds and accessories:
 - 1. Miniblinds with aluminum louver slats.
- B. Related Sections include the following:
 - 1. Division 6 Section "Miscellaneous Carpentry" for wood blocking and grounds for mounting horizontal louver blinds and accessories.

1.3 DEFINITIONS

- A. Miniblind: Venetian blind with nominal 1-inch- (25-mm-) wide louver slat.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
- B. Shop Drawings: Show location and extent of horizontal louver blinds. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other Work, operational clearances, and relationship to adjoining work.
- C. Samples for Initial Selection: For each colored component of each type of horizontal louver blind indicated. Include similar Samples of accessories involving color selection.
- D. Window Treatment Schedule: Include horizontal louver blinds in schedule using same room designations indicated on Drawings.
- E. Maintenance Data: For horizontal louver blinds to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining horizontal louver blinds and finishes.

2. Precautions about cleaning materials and methods that could be detrimental to finishes and performance.
3. Operating hardware.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain horizontal louver blinds through one source from a single manufacturer.
- B. Fire-Test-Response Characteristics: Provide horizontal louver blinds with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 1. Flame-Resistance Ratings: Passes NFPA 701.
- C. Corded Window Covering Product Standard: Provide horizontal louver blinds complying with WCMA A 100.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver blinds in factory packages, marked with manufacturer and product name, fire-test-response characteristics, lead-free designation, and location of installation using same room designations indicated on Drawings and in a window treatment schedule.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Supervising Professional of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

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. Horizontal Louver Blinds, Aluminum Louver Slats:
 - a. Comfortex Window Fashions.
 - b. Hunter Douglas Window Fashions.
 - c. Levolor Contract; a Newell Company; Levolor.
 - d. Springs Window Fashions Division, Inc.; Bali.
 - e. Springs Window Fashions Division, Inc.; Graber.
 - f. Verosol USA, Inc.

2.2 HORIZONTAL LOUVER BLINDS, ALUMINUM LOUVER SLATS HLBA-1

- A. Louver Slats: Aluminum, alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radiused corners.
 1. Nominal Slat Width: 1 inch (25 mm) for miniblinds.
 - a. Slat Spacing: Not less than every 20 mm for 15.2 slats or more per foot (20 mm).
 2. Nominal Slat Thickness: Not less than 0.008 inch (0.20 mm).
 3. Slat Finish: One color as indicated.
 - a. Ionized Coating: Antistatic, dust-repellent, baked polyester finish.
- B. Headrail/Valance: Decorative, integrated headrail/valance not requiring a separate valance or end brackets for finished appearance; formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends; capacity for one blind per headrail, unless otherwise indicated.
 1. Finish Color Characteristics: Match color, texture, pattern, and gloss of louver slats.
- C. Bottom Rail: Formed-steel or extruded-aluminum tube, sealed with plastic or metal capped ends top contoured to match crowned shape of louver slat, bottom contoured for minimizing light gaps; with enclosed and protected ladders and tapes to prevent their contact with sill.
- D. Tilt Control: Consisting of enclosed worm gear mechanism, slip clutch or detachable wand preventing overrotation, and linkage rod, for the following operation:
 1. Tilt Operation: Manual with clear plastic wand.
 2. Tilt: Two-direction, positive stop or lock out limited at an angle of 60 degrees from zero-degree horizontal, both directions.
- E. Lift Operation: Manual, top-locking cord lock; locks pull cord to stop blind in either fully opened or fully closed position only and is equipped with a ring pull not more than 4 inches (100 mm) long.
- F. Ladders: Evenly spaced to prevent long-term louver sag.
 1. For Blinds with Nominal Slat Width 1 Inch (25 mm) or Less: Braided string.

- G. Mounting: End mounting permitting easy removal and replacement without damaging blind or adjacent surfaces and finishes; with spacers and shims required for blind placement and alignment indicated.
 - 1. Provide intermediate support brackets if end support spacing exceeds spacing recommended by manufacturer for weight and size of blind.
- H. Colors, Textures, Patterns, and Gloss: As selected by Supervising Professional from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 HORIZONTAL LOUVER BLIND INSTALLATION

- A. Install blinds level and plumb and aligned with adjacent units according to manufacturer's written instructions, and located so exterior louver edges in any position are not closer than 2 inches (50 mm) to interior face of glass. Install intermediate support as required to prevent deflection in headrail. Allow clearances between adjacent blinds and for operating glazed opening's operation hardware, if any.
- B. Jamb Mounted: Install headrail flush with face of opening jamb and head.

3.3 ADJUSTING

- A. Adjust horizontal louver blinds to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean blind surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged blinds that cannot be repaired, in a manner approved by Supervising Professional, before time of Substantial Completion.

END OF SECTION 12491

1.11.3. Section 12494 – Roller Shades

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 manually operated roller shades.
- B. Related Sections include the following:
 - 1. Division 6 Section "Miscellaneous Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
- B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other Work, operational clearances, and relationship to adjoining work.
 - 1. Shade mounting assembly and attachment.
 - 2. Size and location of access to shade operator, and adjustable components.
 - 3. Minimum Drawing Scale: 1/4 inch = 1 foot (1:48).
- C. Samples for Initial Selection: For each colored component of each type of roller shade indicated. Include similar Samples of accessories involving color selection.
- D. Samples for Verification:
 - 1. Shade Material: Not less than 12-inch- (300-mm-) square section of material from dye lot used for the Work. Mark top and face of material.
- E. Window Treatment Schedule: Include roller shades in schedule using same room designations indicated on Drawings.
- F. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining roller shades and finishes.

2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
3. Operating hardware.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain roller shades through one source from a single manufacturer.
- B. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 1. Flame-Resistance Ratings: Passes NFPA 701.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in a window treatment schedule.

1.6 PROJECT CONDITIONS

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

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. Am-Source International
 2. Custom Laminations, Inc.
 3. Draper Shade & Screen Co., Inc.
 4. Hunter Douglas Window Fashions.

5. Levolor Contract; a Newell Company; Joanna.
6. Silent Gliss USA, Inc.
7. Sol-R-Veil.
8. Springs Window Fashions Division, Inc.; Graber.

2.2 ROLLER SHADES

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- B. Shade Material: Tinted film.
 1. Material Width: Field Verify Width Requirements.
 2. Bottom Hem: Straight
 3. Trim and Fringe: As indicated by manufacturer's designation for style and color.
 4. Material Color: As selected by Supervising Professional from manufacturer's full range.
- C. Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with manufacturer's standard method for attaching shade material.
- D. Direction of Roll: Regular, from back of roller.
- E. Mounting Brackets: Galvanized or zinc-plated steel.
- F. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; removable design for access.
- G. Bottom Bar: Steel or extruded aluminum, with plastic or metal capped ends. Provide concealed, by pocket of shade material, internal-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.
- H. Shade Operation: Manual; bead chain, clutch operation.
- I. Mounting: Inside mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

2.3 ROLLER SHADE FABRICATION

- A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of

attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

- B. Concealed Components: Non-corrodible or corrosion-resistant-coated materials.
 - 1. Lifting Mechanism: With permanently lubricated moving parts.
- C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
 - 1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch (6 mm) from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
- D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting roller, and operating hardware and for hardware position and shade mounting method indicated.
- E. Installation Fasteners: Not fewer than two fasteners per bracket, fabricated from metal non-corrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.
- F. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
- G. Colors of Metal and Plastic Components Exposed to View: As selected by Supervising Professional from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow clearances for window operation hardware.

3.3 ADJUSTING

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

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Supervising Professional, before time of Substantial Completion.

END OF SECTION 12494

1.11.4. Section 12500 - Furniture

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:
 - 1. Seating.
 - 2. Movable tables.
 - 3. Workstations, including surfaces, files, and accessories.
- B. Related Sections include the following:
 - 1. Division 6 Section "Miscellaneous Carpentry" for wood blocking and grounds for mounting furnishings.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
- B. Shop Drawings: Show location and extent of furnishings. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other Work, operational clearances, and relationship to adjoining work.
- C. Samples for Initial Selection: For each colored component of each type of furnishing indicated. Include similar Samples of accessories involving color selection.
- D. Maintenance Data: For furnishings to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining furnishings and finishes.
 - 2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
 - 3. Operating hardware.

1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not furnishings until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where furnishings are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Notify Supervising Professional of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Product: The design is based on the products named in this section. Subject to compliance with the requirements, provide either the named product or a comparable product by the named product or the other manufacturers listed in this section:
- B. 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. Hon.
 - 2. Haworth.
 - 3. Knoll.
 - 4. Steelcase.
 - 5. Teknion.

2.2 OFFICE SEATING

- A. Task Chairs:
 - 1. 5-star base with casters and high-back.
 - 2. Features to include pneumatic seat-height adjustment, two-position back lock, tilt/tension control, synchronized tilt mechanism and height adjustable arm.
 - 3. Fabric grade to be equivalent of Haworth+.
 - 4. Basis-of-Design Product: Improv S.E. Task Chair with Square Back, by Haworth.
- B. Guest Chairs:
 - 1. Features include contoured polypropylene inner shells, stacking design, four legged base, and fixed polypropylene arms.
 - 2. Fabric grade to be equivalent of Haworth+.

3. Basis-of-Design Product Improv Guest Leg-Base Stacking Chair by Haworth.
 4. Quantity: nineteen (19).
- C. Task Stools (counter height):
1. Provide 5-star base chairs with casters suitable for use on quarry tile flooring, with mid-back design.
 2. Features to include adjustments for seat height, back height, six-position back lock, synchronized tilt, standard forward tilt and advanced forward tilt, adjustable polypropylene armcaps, polypropylene back shell.
 3. Fabric grade to be equivalent of Haworth+.
 4. Basis-of-Design Product: Accolade by Haworth.
 5. Quantity: four (4).

2.3 MOVEABLE TABLES

- A. Work Surfaces: Provide plastic laminate writing surface with a self-edge, capable of supporting a minimum of 200 pounds.
- B. Grommets (minimum 2" diameter) and integrated horizontal and vertical wire management systems shall be incorporated into work surface tops.
- C. Size: 24-inch wide x 48-inch.
- D. Leg: Steel with rubber casters sized for specified work surface (provide break on one of the four casters).
- E. Basis of Design Product: Crossings by Haworth.
- F. Quantity: four (4).

2.4 WORK STATIONS

- A. Work Surfaces: Provide plastic laminate writing surfaces with a self-edge, capable of supporting a minimum of 200 pounds.
 1. Grommets (minimum 2" diameter) shall be incorporated into work surface tops.
 2. Where required for stability and at outside exposed ends, work surface height end panels or leg panels shall support one side of a work surface in place of the cantilever.
 3. Work surfaces shall be 24-inches deep by length indicated on the drawings, with circular conferencing ends where indicated.
- B. Pedestals/Drawers: Maximum depth pedestals/drawers shall be used for mounting to the underside of corresponding depth work surfaces.

1. Drawers shall be available in height of 6" and 12". All drawers shall have ball bearing slides, with box drawers having a minimum of $\frac{3}{4}$ length extension and the 12" drawers having full-length extension.
 2. Box Drawers (6"): A box drawer shall be furnished with one (1) stationery divider. Stationery dividers shall have sections capable of accepting letter or legal-size paper.
 3. File Drawers (12"): A file drawer shall accept either letter or legal-size hanging file folders and also be equipped with a compressor. File drawer shall ride on full-extension ball bearing slides.
 4. Basis-of-Design Product: Premise, by Haworth.
 5. Quantity: three (3) box-box-file pedestals and three (3) file-file pedestals.
- C. Pencil Drawers: Manufacturer's standard plastic or metal pencil tray to be mounted beneath work surface.
1. Basis of Design Product: Pelican Drawer by Haworth.
 2. Quantity: (3).
- D. Articulating Keyboard Trays: Provide device featuring height, tilt, depth, swivel, and palm support adjustment.
1. Basis of Design Product: XK99 by Ergo systems Inc.
 2. Quantity: Four (4).

2.5 MOBILE FILE CABINETS (PEDESTALS)

- A. Mobile File Cabinets: Manufacturer's locking, mobile file storage located beneath north counter in room 112. File drawers to be configured for suspended letter-sized filing. Coordinate pedestal height with clearance beneath counter (refer to drawings).
1. Basis of Design Product: "Storage Centers" by Office Specialty.
 2. Size: 15" wide x 18" deep x 32.5" high (not including casters).
 3. Drawer Configuration: 12-inch drawer, 12-inch drawer, 6-inch drawer.
 4. Mobility: Provide manufacturer's mobile version.
 5. Quantity: Six (6).

2.6 MISCELLANEOUS ACCESSORIES

- A. Provide all systems components and manufacturer-suggested brackets, panels, and posts for stabilization of furnishings components. Miscellaneous hardware is the responsibility of the supplying dealer.
- B. Wire Management: Provide devices to contain and conceal both horizontal and vertical electrical and communications wiring beneath all work surfaces and moveable tables.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install furnishings complete with accessories according to manufacturer's recommendations. Install plumb, level, rigid, and flush.
- B. Anchor furnishings to floors and walls at intervals recommended by manufacturer.

3.2 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust furnishings and accessories per manufacturer's recommendations.
- B. Clean exposed exterior surfaces and interiors of all drawers and bins.
- C. Protect furnishings from damage, abuse, dust, dirt, stain, or paint. Do not permit furnishing use during construction.
- D. Touch up marred finishes, or replace components that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by manufacturer.
- E. Instruct Owner's Representative on how to properly operate and maintain all furnishings.

END OF SECTION 12500

39. SWEF Building, Plumbing, Item SPV.0105.12.

A Description

This item consists of the plumbing work for the SWEF building. The work shall be in accordance with the applicable plans and the following specifications.

B Measurment

The department will measure SWEF Building, Plumbing, completed in accordance to the contract and accepted, as a single complete unit of work.

C Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.12	SWEF Building, Plumbing	LS

Payment shall be full compensation for furnishing all materials and equipment; and for supplying all labor, tools, equipment, and incidentals necessary to complete the work.

1.1. Section 15400 - Basic Plumbing Materials And Methods

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- D. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
 2. CPVC: Chlorinated polyvinyl chloride plastic.
 3. PE: Polyethylene plastic.
 4. PVC: Polyvinyl chloride plastic.
- E. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 2. NBR: Acrylonitrile-butadiene rubber.

1.3 QUALITY ASSURANCE

- A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 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.

1.5 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."
- D. Coordination Meetings: Attend coordination meetings with the construction manager and all other trades for the purpose of coordinating the locations of all fire protection, plumbing, HVAC and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field.
- E. Coordination Drawings: Each fire protection, plumbing, HVAC and electrical contractor shall develop 1/4" coordination floor plan drawings for all of their respective working areas that necessitate additional coordination to allow for efficient systems installation. Each coordination drawing, for all trades, shall be signed and dated by each trade indicating that each trade has fully coordinated their work
- F. Conflicts Between Trades: Resolve all conflicts with other trades at no additional cost to the Owner or Architect.
- G. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of fire

protection, plumbing, HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.

1.6 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. These specifications and attendant drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with present practices of the trade shall not relieve the Contractor from providing such additional labor and materials.
- B. The drawings depicting plumbing work are diagrammatic and show, in their approximate location, symbols representing plumbing equipment and devices. The exact location of such equipment and devices shall be established in the field in accordance with instructions from the Architect and/or established by manufacturer's installation drawings and details.
 - 1. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring plumbing connections to verify rough-in and connection locations.
 - 2. Unless specifically stated to the contrary, no measurement of a plumbing drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the plumbing drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

1.7 DRAWINGS

- A. The plumbing drawings do not attempt to show the complete details of building construction which affect the plumbing installation. The Contractor shall refer to the architectural, civil, structural and mechanical, and electrical drawings for additional details which affect the proper installation of this work. Bring any discrepancies to the attention of the A/E for resolution. The Contractor is cautioned that diagrams showing plumbing connections and/or piping are diagrammatic only and must not be used for obtaining linear runs of piping. Piping diagrams do not necessarily show the exact physical arrangement of the equipment.
- B. The Engineer will make available to the contractor a complete set of plan sheets in AutoCAD version 2000 format. Each copy of electronic plan sheet requested will be put on disk for the cost of \$200 to cover technician time and mailing costs. Any requests shall be made in writing to the Engineer with a certified check or

money order payable to the Engineer. The disk(s) will be sent out within 7 days of receipt of the request and payment in full.

1.8 MATERIAL AND EQUIPMENT

- A. All material and equipment shall be new and of the quality used for the purpose in good commercial practice, and shall be standard product of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, catalog number, and capacity or rating on a nameplate, securely affixed on the equipment in a conspicuous place.

1.9 DAMAGE TO OTHER WORK

- A. The Plumbing Contractor will be held rigidly responsible for all damages to the work of his own or any other trade resulting from the execution of his work. It shall be the Contractor's responsibility to adequately protect his work at all times. All damages resulting from his operations shall be repaired or the damaged portions replaced by the party originally performing the work, (to the entire satisfaction of the Engineer), and all cost thereof shall be borne by the Contractor responsible for the damage.

1.10 COOPERATION WITH OTHER TRADES

- A. This Contractor shall completely cooperate with all other trades in the matter of planning and executing of the work. Every reasonable effort shall be made to prevent conflict and interferences as to space requirements, dimensions, locations, openings, sleeving or other matters which tend to delay or obstruct the work of any trade.

1.11 NEGLIGENCE

- A. Should the Contractor fail to provide materials, templates, etc., or other necessary information causing delay or expense to another party, he shall pay the actual amount of the damages to the party who sustained the loss.

1.12 FIELD CHANGES

- A. Should any change in drawings or specifications be required to comply with local regulations and/or field conditions, the Contractor shall refer same to Architect for approval before any work which deviates from the original requirements of the drawings and specifications is started. In the event of disagreements as to the necessity of such changes, the decision of the Architect shall be final.

1.13 CUTTING AND PATCHING

- A. As necessary and with approval to permit the installation of piping or any part of the work under this branch. Any cost caused by defective or ill-timed work shall be by the party responsible there for. Patching of holes, openings, etc. resulting from the work of this branch shall be furnished by this Contractor.

1.14 STANDARDS, CODES AND PERMITS

- A. All work shall be installed in accordance with National, State and Local plumbing codes, laws, ordinances and regulations. Comply with all applicable OSHA regulations.
- B. All materials shall have a U.L. label where a U.L. standard and/or test exists.
- C. Prepare and submit to all authorities having jurisdiction, for their approval, all applications and working drawings required by them. Secure and pay for all permits and licenses required.

1.15 CLEAN-UP

- A. This Contractor shall at all times keep the premises free from excessive accumulation of waste material or rubbish resulting from his work, including tools, scaffolding and surplus materials, and he shall leave his work broom-clean or its equivalent. In case of disputes, the Architect may order the removal of such rubbish and charge the cost to the responsible contractor as determined by the Architect. At the time of final clean-up all fixtures and equipment shall be thoroughly cleaned and left in proper condition for their intended use.

1.16 GUARANTEE

- A. The Contractor shall unconditionally guarantee his work and all components thereof for a period of one year from the date of his final payment. He shall remedy any defects in workmanship and repair or replace any faulty equipment which shall appear within the guarantee period to the entire satisfaction of the Architect at no additional charge.

1.17 SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN

- A. Such requests shall be accompanied by three copies of all necessary illustrations, cuts, drawings and descriptions of material proposed for substitution and shall fully describe all points in which it differs from the articles specified. The Engineer will retain two copies and one copy returned to the Contractor with acceptance, rejection or revisions indicated thereon.

- B. The proposed substitution does not affect dimensions shown on Drawings or as specified.
- C. The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.
- D. All proposed substitutions will be subject to satisfactory performance to the specification and considered as a deduct alternate rather than as an equivalent.
- E. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs, including architectural/engineering design and construction costs, involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- F. All substitution review costs shall be reimbursed to the Engineer by the contractor or their suppliers on a Time/Material bases. This cost shall be paid on approval or disapproval of the substitution material, equipment or design.

1.18 SHOP DRAWINGS

- A. Submit to Engineer for review, copies of manufacturer's shop drawings and/or equipment brochure depicting items in this specification.
- B. Other materials at the request of the Engineer.
- C. Shop drawings shall bear the Contractor's stamp indicating approval.
- D. Any equipment fabrication prior to shop drawing review shall be at the Contractor's risk.
- E. Any shop drawing not meeting the requirements as outlined in this or any other part of this specification or drawing, requiring more then two reviews or in excess of 4 hours of total review time shall have a fee of reimbursement to the Engineer by the contractor or their suppliers. This shall be done on a Time/Material bases. This cost shall be paid on approval on disapproval of the material, equipment or design.

1.19 WORKMANSHIP

- A. The installation of all work shall be made so that its several component parts will function as a workable system complete with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The work shall be executed in conformity with the best-accepted standard

practice of the trade so as to contribute to efficiency and appearance. It shall also be executed so that the installation will conform and adjust itself to the building structure, its equipment and its usage.

1.20 DRAWINGS OF OTHER TRADES

- A. The Contractor shall consult the drawings of the work for the various other trades; field layouts of the parties performing the work of the other trades; their shop drawings, and he shall be governed accordingly in laying out his work.

1.21 FIELD MEASUREMENTS

- A. The Contractor shall take all field measurements necessary for his work and shall assume the full responsibility for their accuracy.

1.22 STRUCTURAL INTERFERENCES

- A. Should any structural interference prevent the installation of the fixtures, running of piping, etc., at points shown on drawings, the necessary minor deviation there from, as determined by the Architect, may be permitted. Minor changes in the position of the fixtures, equipment or piping if decided upon before any work has been done by the Contractor shall be made without additional charge.

1.23 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

- A. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points with the Engineer before submitting his bid. In lieu of written clarification by addendum, the contractor shall resolve all conflicts in favor of the greater quantity or better quality.

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 15 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 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - a) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- 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. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 3. 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. Co.
 - b) Dresser Industries, Inc.; DMD Div.
 - c) Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d) Viking Johnson.
 - 2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
 - 3. Underground Piping NPS 2 (DN 50) 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.
- C. 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.
- D. 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. Co.
 - b) Fernco, Inc.
 - c) Mission Rubber Company.
 - d) Plastic Oddities, Inc.

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 Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
 1. Manufacturers:
 - a) Eclipse, Inc.
 - b) Epco Sales, Inc.
 - c) Hart Industries, International, Inc.
 - d) Watts Industries, Inc.; Water Products Div.
 - e) Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 1. Manufacturers:
 - a) Calpico, Inc.
 - b) Lochinvar Corp.
- E. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 1. Manufacturers:

- a) Precision Plumbing Products, Inc.
- b) Sioux Chief Manufacturing Co., Inc.
- c) Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a) Advance Products & Systems, Inc.
 - b) Calpico, Inc.
 - c) Metraflex Co.
 - d) Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM 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. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. PVC Pipe: ASTM D 1785, Schedule 40.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated and rough brass.

- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated and rough brass.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 – EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c) Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - f) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
 - g) Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - h) Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - i) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a) Exception: Extend sleeves installed in floors of mechanical equipment

areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a) Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
 - b) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
 - c) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 3. 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.
 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
 5. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- I. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
 - J. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
 - K. 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.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. [Extend grease fittings to accessible locations.]
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 9 Section ".
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 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 (100 mm) 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 (450-mm) 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 (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section.

3.7 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

1.2. Section 15406 - Plumbing Hangers And Supports

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes hangers and supports for plumbing system piping and equipment.
- B. Related Sections include the following:
 - 1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pipe Hangers:
 - a) B-Line Systems, Inc.
 - b) Carpenter & Patterson, Inc.
 - c) Grinnell Corp.

- d) Michigan Hanger Co., Inc.
 - e) National Pipe Hanger Corp.
- 2. Channel Support Systems:
 - a) B-Line Systems, Inc.
 - b) Grinnell Corp.; Power-Strut Unit.
 - c) Michigan Hanger Co., Inc.; O-Strut Div.
 - d) National Pipe Hanger Corp.
 - e) Unistrut Corp.
- 3. Thermal-Hanger Shield Inserts:
 - a) Carpenter & Patterson, Inc.
 - b) Michigan Hanger Co., Inc.
 - c) Pipe Shields, Inc.
 - d) Rilco Manufacturing Co., Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 - 1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 2. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 – EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification 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. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 4. Adjustable Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 5. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 - 6. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
 - 7. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
 - 8. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification 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.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification 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. 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. 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.
 10. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 11. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 12. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification 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 by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.
- E. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

- H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- J. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c) Do not exceed pipe stress limits according to ASME B31.9.
 - 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 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.
 - 5. Insert Material: Length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

1.3. Section 15407 - Plumbing Identification

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following plumbing identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Equipment signs.
 - 3. Access panel and door markers.
 - 4. Pipe markers.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Valve schedules.
 - 8. 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. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 – PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a) Manufacturer, product name, model number, and serial number.
 - b) Capacity, operating and power characteristics, and essential data.
 - c) Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Data: Instructions for operation of equipment and for safety procedures.
 - 2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
 - 3. Thickness: 1/16 inch, unless otherwise indicated.
 - 4. Fasteners: Self-tapping, stainless steel screws or contact-type, permanent adhesive.
- C. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
 - 1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 - 2. Pipes with OD, Including Insulation, less than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 - 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 - 4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

- C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.
 - 1. Stencil Material: Metal or fiberboard .
 - 2. Stencil Paint: Exterior, gloss, alkyd enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, alkyd 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, with numbering scheme approved by Owner. Provide 5/32-inch hole for fastener.
 - 1. Material: 0.032-inch- thick brass or aluminum.
 - 2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.5 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 - 2. Frame: Extruded aluminum.

3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 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 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 1. Fuel-burning units, including water heaters,
 2. Pumps
 3. Sewage Ejectors
 4. Water Softeners
- B. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Pipes with OD, Including Insulation, less than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
 - 2. Pipes with OD, Including Insulation, less than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
 - 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed 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 non-accessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme. and with captions similar to those indicated in the following:

C. Other valve-tag sizes, shapes, colors, and letter colors may be available if required.

1. Valve-Tag Size and Shape:
 - a) Cold Water: 1-1/2 inches.
 - b) Hot Water: 1-1/2 inches.
 - c) Fire Protection: 1-1/2 inches.
 - d) Gas: 1-1/2 inches.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

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

3.7 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION

1.4. Section 15412 - Plumbing Pipe Insulation

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Division 15 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.2 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for insulation application.
- C. Coordinate installation and testing of electric heat tracing.

1.6 SCHEDULING

- A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a) CertainTeed Manson.
 - b) Knauf FiberGlass GmbH.
 - c) Owens-Corning Fiberglas Corp.
 - d) Schuller International, Inc.
 - 2. Flexible Elastomeric Thermal Insulation:
 - a) Armstrong World Industries, Inc.
 - b) Rubatex Corp.
 - 3. Closed-Cell Phenolic-Foam Insulation:
 - a) Kooltherm Insulation Products, Ltd.
 - b) Knauf
 - c) Thermico

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 - 2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a) Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b) Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.

3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 5. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
 6. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
- B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Adhesive: As recommended by insulation material manufacturer.
 2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
- C. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
1. Adhesive: As recommended by insulation material manufacturer.
 2. PVC Jacket Color: White or gray.
 3. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.
- D. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 2. Adhesive: As recommended by insulation material manufacturer.

2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.
1. Tape Width: 4 inches.

- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 - 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
 - 2. Galvanized Steel: 0.005 inch thick.
 - 3. Aluminum: 0.007 inch thick.
 - 4. Brass: 0.010 inch thick.
 - 5. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

- E. Apply 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch- wide strips, of same material

- as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a) Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- Q. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- R. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with standard PVC fitting covers.
- D. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Follow manufacturer's written instructions for applying insulation.
 2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- B. Apply insulation to flanges as follows:
1. Apply pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- C. Apply insulation to fittings and elbows as follows:
1. Apply mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- D. Apply insulation to valves and specialties as follows:
1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
 2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to stainer basket.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.6 CLOSED-CELL PHENOLIC-FOAM INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of

- block insulation of the same material and thickness as pipe insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded sections of insulation are not available, apply mitered sections of phenolic-foam insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with standard PVC fitting covers.
 4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- D. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded sections of insulation are not available, apply mitered segments of phenolic-foam insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.
- E. Foil and Paper Jackets: Apply foil and paper jackets where indicated.
1. Draw jacket material smooth and tight.
 2. Apply lap or joint strips with the same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

- F. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

3.7 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Flexible connectors.
 - 2. Vibration-control devices.
 - 3. Drainage piping located in crawl spaces, unless otherwise indicated.
 - 4. Below-grade piping, unless otherwise indicated.
 - 5. Chrome-plated pipes and fittings, unless potential for personnel injury.
 - 6. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.8 FIELD QUALITY CONTROL

- A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
 - 1. Inspect fittings and valves randomly selected by Architect.
- B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.
- C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.9 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.10 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot and recirculated hot water.
 - 1. Operating Temperature: 60 to 140 deg F.
 - 2. Insulation Material: Mineral fiber.

3. Insulation Thickness: 1 (one) inch.
 4. Vapor Retarder Required: No.
 5. Finish: None.
- B. Service: Domestic cold water.
1. Operating Temperature: 35 to 60 deg F.
 2. Insulation Material: Mineral fiber.
 3. Insulation Thickness: 1 (one) inch.
 4. Vapor Retarder Required: Yes.
 5. Finish: Painted.
- C. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.
1. Operating Temperature: 35 to 120 deg F.
 2. Insulation Material: Mineral fiber .
 3. Insulation Thickness: 1 (one) inch
 4. Field-Applied Jacket: PVC P-trap and supply covers.

END OF SECTION

1.5. Section 15420 - Plumbing Valves

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Copper-alloy ball valves.
 - 2. Bronze check valves.
 - 3. Spring-loaded, lift-disc check valves.
- B. Related Sections include the following:
 - 1. Division 2 piping Sections for general-duty and specialty valves for site construction piping.
 - 2. Division 15 Section "Mechanical Identification" for valve tags and charts.
 - 3. Division 15 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. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping and storage as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.

4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Block check valves in either closed or open position.

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 2 and smaller with threaded ends, unless otherwise indicated.
- C. Bronze Valves: NPS 2-1/2 to 4 with grooved ends, unless otherwise indicated.
- D. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- G. Valve Actuators:
 1. Handwheel: For valves other than quarter-turn types.
 2. Lever Handle: For quarter-turn valves NPS 6 and smaller.
- H. Extended Valve Stems: On insulated valves.
- I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- J. Valve Grooved Ends: AWWA C606.
 1. Solder Joint: With sockets according to ASME B16.18.
 - a) Caution: Use solder with melting point below 840 deg F for, check, gate, and globe valves; below 421 deg F for ball valves.
 2. Threaded: With threads according to ASME B1.20.1.
- K. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

- A. Manufacturers:
 - 1. Copper-Alloy Ball Valves:
 - a) Grinnell Corporation.
 - b) Milwaukee Valve Company
 - c) NIBCO INC.
 - d) Watts Industries, Inc.; Water Products Div.
 - 2. Safety-Exhaust, Copper-Alloy Ball Valves:
 - a) Grinnell Corporation.
 - b) Milwaukee Valve Company.
 - c) NIBCO INC.
- B. Copper-Alloy Ball Valves, General: MSS SP-110.
- C. Two- or Three-Piece, Copper-Alloy Ball Valves: Bronze body with full -port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
- D. Safety-Exhaust, Copper-Alloy Ball Valves: Two- or three-piece bronze body with exhaust vent opening, chrome-plated ball with vent, blowout-proof stem, locking handle, and working pressure rating of 600-psig CWP.

2.4 BRONZE CHECK VALVES

- A. Manufacturers:
 - 1. Type 3, Bronze, Swing Check Valves with Metal Disc:
 - a) Grinnell Corporation.
 - b) Milwaukee Valve Company.
 - c) NIBCO INC.
 - d) Red-White Valve Corp.
 - e) Watts Industries, Inc.; Water Products Div.
- B. Bronze Check Valves, General: MSS SP-80.
- C. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

2.5 SPRING-LOADED, LIFT-DISC CHECK VALVES

- A. Manufacturers:
 - 1. Type II, Compact-Wafer, Lift-Disc Check Valves:
 - a) Grinnell Corporation.
 - b) Milwaukee Valve Company.
 - c) NIBCO INC.
 - 2. Type III, Globe Lift-Disc Check Valves:

- a) Grinnell Corporation.
 - b) Milwaukee Valve Company.
 - c) NIBCO INC.
- 3. Type IV, Threaded Lift-Disc Check Valves:
 - a) Grinnell Corporation.
 - b) Milwaukee Valve Company.
 - c) NIBCO INC.
 - d) Watts Industries, Inc.; Water Products Div.
- B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.
- C. Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.
- D. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.
- E. Type IV, Class 125, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

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: Ball valves.
 - 2. Throttling Service: Ball valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Domestic Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
 - 2. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
 - 3. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type II or III, Class 125, cast iron.
- D. Sanitary Waste and Storm Drainage Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
 - 2. Check Valves, NPS 2 and Smaller: Type 3, Class 125, bronze.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 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 check valves for proper direction of flow and as follows:
 - 1. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" 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

1.6. Section 15430 - Domestic Water Piping

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes domestic water piping from locations indicated to fixtures and equipment inside the building.
- B. Related Sections include the following:
 - 1. Division 15 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
 - 2. Division 15 Section "Plumbing Specialties" for water distribution piping specialties.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Distribution Piping: 125 psig.

1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 – PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 COPPER TUBING

- A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
 4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 - a) Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

2.3 VALVES

- A. Refer to Division 15 Section "Valves" for bronze and cast-iron, general-duty valves.
- B. Refer to Division 15 Section "Plumbing Specialties" for balancing and drain valves.

PART 3 – EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- 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 may be used on aboveground piping, unless otherwise indicated.

- C. Grooved joints may be used on aboveground grooved-end piping.
- D. Fitting Option: Mechanically formed tee-branch outlets and brazed joints may be used on aboveground copper tubing.
- E. Aboveground Domestic Water Piping: Use any of the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 2. NPS 2-1/2 to NPS 3-1/2: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 3. NPS 2-1/2 to NPS 3-1/2: Use NPS 2-1/2 to NPS 4 hard copper tube, Type L with grooved ends; copper grooved-end fittings; copper-tubing, keyed couplings; and grooved joints.

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use bronze ball valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 - 4. Drain Duty: Hose-end drain valves.

3.4 PIPING INSTALLATION

- A. Refer to Division 2 Section "Water Distribution" for site water distribution and service piping.
- B. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- C. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.
- D. Install underground copper tubing according to CDA's "Copper Tube Handbook."
- E. Install underground PEX tubing according to ASTM D 2774 and ASTM F 645.
- F. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for wall penetration systems.

- G. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each domestic water service. Refer to Division 15 Section "Meters and Gages" for pressure gages, and to Division 15 Section "Plumbing Specialties" for drain valves and strainers.
- H. Install aboveground domestic water piping level and plumb.
- I. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- J. Perform the following steps 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. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 - 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 6. Remove filter cartridges from housings, and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.
- K. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- L. Check plumbing specialties and verify proper settings, adjustments, and operation.
 - 1. Water-Pressure Regulators: Set outlet pressure at 80 psig maximum, unless otherwise indicated.
- M. Energize pumps and verify proper operation.

3.5 JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. 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.
- C. Grooved Joints: Assemble joints with keyed-coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- D. Mechanically Formed Outlets: Form tee in copper tube according to equipment manufacturer's written instructions. 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.

3.6 VALVE INSTALLATION

- A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops. Use ball or gate valves for piping NPS 2 and smaller. [Use butterfly or gate valves for piping NPS 2-1/2 and larger.]
- C. Install drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves at low points in water mains, risers, and branches.
 - 2. Install stop-and-waste drain valves where indicated.
- D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Refer to Division 15 Section "Plumbing Specialties" for calibrated balancing valves.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 15 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a) 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- B. Install supports according to Division 15 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- E. 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.

- F. Install supports for vertical copper tubing every 10 feet.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to service piping with shutoff valve, and extend and connect to the following:
 - 1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section "Plumbing Fixtures."
 - 3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection.

3.9 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - 2. 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:
 - a) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b) Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- B. Test domestic water piping 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 domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. 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.
 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.

3.10 ADJUSTING

- A. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
1. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 2. Adjust calibrated balancing valves to flows indicated.

3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a) Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b) Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c) Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

1.7. Section 15431 - Sanitary Waste And Vent Piping

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes soil and waste, sanitary drainage and vent piping inside the building and to locations indicated.
- B. Related Sections include the following:
 - 1. Division 15 Section "Chemical-Waste Piping" for chemical-waste and vent piping systems.
 - 2. Division 15 Section "Plumbing Specialties" for soil, waste, and vent piping systems specialties.
 - 3. Division 15 Section "Sewage Pumps" for drainage connections for effluent pumps.

1.2 DEFINITIONS

- A. The following are industry abbreviations for plastic and rubber piping materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. EPDM: Ethylene-propylene-diene terpolymer.
 - 3. NBR: Acrylonitrile-butadiene rubber.
 - 4. PE: Polyethylene plastic.
 - 5. PVC: Polyvinyl chloride plastic.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Sanitary Sewer, Force-Main Piping: 50 psig.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings: For solvent drainage system, include plans, elevations, sections, and details.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 – PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Flexible Transition Couplings for Underground Non-pressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.
- C. Transition Couplings for Underground Pressure Piping: AWWA C219 metal, sleeve-type coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 CAST-IRON SOIL PIPING

- A. Hub-and-Spigot Pipe and Fittings: ASTM A 74, Service class.
 - 1. Gaskets: ASTM C 564, rubber.
- B. Hubless Pipe and Fittings: ASTM A 888 or CISPI 301.
 - 1. Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral, center pipe stop.
 - a) Heavy-Duty, Type 304, Stainless-Steel Couplings: ASTM A 666, Type 304, stainless-steel shield; stainless-steel bands; and sleeve.
 - 1) NPS 1-1/2 to NPS 4: 3-inch- wide shield with 4 bands.
 - b) Compact, Stainless-Steel Couplings: CISPI 310 with ASTM A 167, Type 301, or ASTM A 666, Type 301, stainless-steel corrugated shield; stainless-steel bands; and sleeve.
 - 1) NPS 1-1/2 to NPS 4: 2-1/8-inch- wide shield with 2 bands.
 - 2. Sovent Fittings: ASME B16.45 or ASSE 1043, hubless, aerator and deaerator.

2.3 COPPER TUBING

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- B. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- C. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.4 PVC PIPING

- A. PVC Pipe: Schedule 40 ASTM D 2665, solid-wall drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Cellular-Core, Schedule 40, PVC Pipe: ASTM F 891, Schedule 40.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drainpipe.
- D. PVC Special Fittings: ASTM F 409, drainage-pattern tube and tubular fittings with ends as required for application.

PART 3 – EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground pressure piping, unless otherwise indicated.
- C. Aboveground, Soil, Waste, and Vent Piping: Use [any of] the following piping materials for each size range:
 - 1. Solvent Fittings: NPS 3 to NPS 8.
 - 2. NPS 1-1/4 and NPS 1-1/2: Use NPS 1-1/2 hubless, cast-iron soil piping and one of the following:
 - a) Couplings: Heavy-duty, Type 301, stainless steel.
 - b) Couplings: Compact, stainless steel.
 - 3. NPS 1-1/4 and to NPS 1-1/22: Copper DWV tube, copper drainage fittings, and soldered joints.
 - 4. NPS 1-1/4 and to NPS 1-1/28: PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 5. NPS 1-1/4 and to NPS 1-1/28: Cellular-core, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 - 6. NPS 2 to NPS 4: Service class, cast-iron soil piping; gaskets; and gasketed joints.
 - 7. NPS 2 to NPS 4: Hubless, cast-iron soil piping and one of the following:
 - a) Couplings: Heavy-duty, Type 301, stainless steel.
 - b) Couplings: Compact, stainless steel.
 - 8. NPS 2 to NPS 4: Copper DWV tube, copper drainage fittings, and soldered joints.
 - a) Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 - 9. NPS 2 to NPS 4: PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 10. NPS 2 to NPS 4: Cellular-core, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
- D. Underground, Soil, Waste, and Vent Piping: Use any of the following piping materials for each size range:
 - 1. NPS 1-1/2: Hubless, cast-iron soil piping and one of the following:
 - a) Couplings: Heavy-duty, Type 301, stainless steel.
 - b) Couplings: Compact, stainless steel.

2. NPS 1-1/2: PVC pipe, PVC socket fittings, and solvent-cemented joints.
 3. NPS 1-1/2: Cellular-core, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 4. NPS 2 to NPS 4: Service class, cast-iron soil piping; gaskets; and gasketed joints.
 5. NPS 2 to NPS 4: Hubless, cast-iron soil piping and one of the following:
 - a) Couplings: Heavy-duty, Type 301, stainless steel.
 - b) Couplings: Compact, stainless steel.
- E. Aboveground Sanitary-Sewage Force Mains: Use any of the following piping materials for each size range:
1. NPS 1-1/2: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. NPS 1 1/2 to NPS 4: Hard copper tube, Type L; copper pressure fittings; and soldered joints.

3.3 PIPING INSTALLATION

- A. Refer to Division 2 Section "Sanitary Sewerage" for Project-site sanitary sewer piping.
- B. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals.
- F. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for wall penetration systems.
- G. 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. Encase underground piping with PE film according to ASTM A 674 or AWWA C105.

- H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. 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.
- K. Install engineered soil and waste drainage and vent piping systems in locations indicated and as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Cast-Iron, Solvent, Single Stack: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- M. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- 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.
- D. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

- A. Refer to Division 15 Section "Valves" for general-duty valves.
- B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
 - 1. Use gate or full-port ball valve for piping NPS 2 and smaller.
- C. Check Valves: Install swing check valve, downstream from shutoff valve, on each sewage pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 15 Section "Mechanical Vibration Controls and Seismic Restraints" for seismic-restraint devices.
- B. Refer to Division 15 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - 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.
- C. Install supports according to Division 15 Section "Hangers and Supports."

- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. 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. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
- I. Install supports for vertical copper tubing every 10 feet.
- J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 - 2. NPS 3: 48 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- K. Install supports for vertical PVC piping every 48 inches.
- L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

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. Refer to Division 15 Section "Plumbing Fixtures."

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. Refer to Division 15 Section "Plumbing Specialties."
 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main or sanitary manhole.
 2. Sewage Pumps: To sewage pump discharge.

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 and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.
- 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 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION

1.8. Section 15440 - Plumbing Fixtures

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes plumbing fixtures and related components.
- B. Related Sections include the following:
 - 1. Division 15 Section "Emergency Plumbing Fixtures."
 - 2. Division 15 Section "Drinking Fountains and Water Coolers."
 - 3. Division 15 Section "Plumbing Specialties" for backflow preventers and specialty fixtures not in this Section.

1.2 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of 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.

1.3 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

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"; about plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.
- E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Hand Sinks: NSF 2 construction.
 - 3. Vitreous-China Fixtures: ASME A112.19.2M.
- I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucet Hose: ASTM D 3901.
 - 5. Faucets: ASME A112.18.1M.
 - 6. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 7. Hose-Coupling Threads: ASME B1.20.7.
 - 8. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 9. NSF Materials: NSF 61.
 - 10. Pipe Threads: ASME B1.20.1.
 - 11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - 12. Supply and Drain Fittings: ASME A112.18.1M.

- J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Brass and Copper Supplies: ASME A112.18.1M.
 - 3. Manual-Operation Flushometers: ASSE 1037.
 - 4. Plastic Tubular Fittings and Piping: ASTM F 409.
 - 5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
 - 6. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.
- K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Disposers: ASSE 1008 and UL 430.
 - 2. Floor Drains: ASME A112.21.1M.
 - 3. Grab Bars: ASTM F 446.
 - 4. Hose-Coupling Threads: ASME B1.20.7.
 - 5. Hot-Water Dispensers: ASSE 1023 and UL 499.
 - 6. Off-Floor Fixture Supports: ASME A112.6.1M.
 - 7. Pipe Threads: ASME B1.20.1.
 - 8. Plastic Shower Receptors: ANSI Z124.2.
 - 9. Plastic Toilet Seats: ANSI Z124.5.
 - 10. Supply and Drain Protective Shielding Guards: ICC A117.1.
 - 11. Whirlpool Bathtub Equipment: UL 1795.

1.5 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet, Laminar-Flow Fittings: Equal to 10 percent of amount of each type and size installed, but not less than 2 of each type and size.
 - 3. Faucet, Flow-Control Fittings: Equal to 10 percent of amount of each type and size installed.
 - 4. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but not less than 12 of each type.
 - 5. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Fixture descriptions establish fixture type, quality, materials, features and size. Products of the following manufacturers determined to be equal by the Architect/Engineer will be accepted:
1. Carriers and Supports Josam, Jay R. Smith, MIFAB, Wade, Zurn.
 2. Faucets, Sink - Chicago Faucets, Kohler, Elkay, Zurn
 3. Faucets, Lavatory - Chicago Faucets, Kohler, Zurn
 4. Flush Valves Sloan, Zurn
 5. Disposers – Grainger, In-Sink-Erator, Waste King
 6. Drains, Supplies and Stops Brass Craft, Chicago Faucets, Kohler, McGuire, Zurn
 7. Interceptors – J.R. Smith, Josam, Schier Co, Zurn
 8. Laundry Tray – Crane/Fiat, Mustee
 9. Protective Shielding Guards – Truebro, Plumberex
 10. Service Basins – Acorn, Crane/Fiat, Mustee
 11. Service Sinks – Crane/Fiat, Kohler
 12. Stainless Steel Sinks American Standard, Elkay, Kohler.
 13. Traps American Standard, Kohler, McGuire.
 14. Toilet Seats – Bemis, Kohler, Olsonite
 15. Water Closets, Urinals and Lavatories American Standard, Kohler, Crane.
 16. Water Closet Seats Bemis, Kohler, Olsonite

2.2 PLUMBING FIXTURES.

- A. Coordinate finishes and colors of all exposed fixtures, faucets and trim with Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
 - 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-hanging fixtures onto waste fitting seals and attach to supports.
- D. Install wall-hanging 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 manufacturers' written instructions and 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, gate, or globe valve if stops are not specified with fixture. Refer to Division 15 Section "Valves" for general-duty valves.
- 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 flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- K. Install toilet seats on water closets.
- L. 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.

- M. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- N. 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.
- O. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- P. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not 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. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for escutcheons.
- R. Set service basins in leveling bed of cement grout. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for grout.
- S. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.
- F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed 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.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets, flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 2. Remove sediment and debris from drains.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

1.9. Section 15441 - Emergency Plumbing Fixtures

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following emergency plumbing fixtures:
 - 1. Combination units.

1.2 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Cooled Water: Cooled potable water produced by water cooler.
- C. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- D. PVC: Polyvinyl chloride plastic.
- E. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- F. Tepid: Approximately 85 deg F temperature.
 - 1. Allowable Variation: Plus or minus 5 deg F.

1.3 SUBMITTALS

- A. Product Data: Include flow rates and capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- 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"; about plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.
- E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.5 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. For fixture descriptions in other Part 2 articles where the subparagraph titles "Available Products" introduce a list of manufacturers and their products, the following requirements apply for product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified in other Part 2 articles.

2.2 COMBINATION UNITS

- A. Combination Units: Plumbed, accessible, freestanding type with emergency shower and eye/face wash equipment.
 1. Piping: Galvanized steel [PVC].
 - a) Unit Supply: NPS 1-1/4 minimum from side.
 - b) Unit Drain: Outlet at side near bottom.
 - c) Shower Supply: NPS 1 with flow regulator and stay-open control valve.
 - d) Eye/Face Wash Supply: NPS 1/2 with flow regulator and stay-open control valve.
 2. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
 - a) Control-Valve Actuator: Pull rod .
 - b) Shower Head: 8-inch minimum diameter, plastic.
 3. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
 - a) Control-Valve Actuator: Aluminum Flag Handle.
 - b) Receptor: Chrome-plated brass or stainless-steel bowl.

2.3 SOURCE QUALITY CONTROL

- A. Certify performance of plumbed emergency plumbing fixtures by independent testing agency 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. 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 according to manufacturer's written instructions.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.

- D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve 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. Refer to Division 15 Section "Valves" for general-duty shutoff valves.
 - 1. Exception: Omit shutoff valves on valved supplies to group of plumbing fixtures that includes emergency plumbing fixture.
 - 2. Exception: Omit shutoff valves on supplies to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping.
- F. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for dielectric fittings.
- G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.
- H. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Refer to Division 15 Section "Drainage and Vent Piping" for piping.
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for escutcheons.
- J. Fill self-contained fixtures with flushing fluid.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment.
- C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.
- D. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.

3.4 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

3.5 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

1.10. Section 15442 - Water Coolers

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Water-station water coolers.

1.2 DEFINITIONS

- A. Accessible Drinking Fountain and Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
- C. Fitting: Device that controls flow of water into or out of fixture.
- D. Fixture: Drinking fountain or water cooler, unless one is specifically indicated.
- E. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each type of fixture indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Maintenance Data: For fixtures to include in maintenance manuals specified in Division.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. 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";] about fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in the U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about fixtures for people with disabilities.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

1.5 COORDINATION

- A. Coordinate roughing-in and final fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. For fixture descriptions in other Part 2 articles where the subparagraph titles "Available Products," introduce a list of manufacturers and their products or manufacturers only, the following requirements apply for product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified in other Part 2 articles.

2.2 PRESSURE WATER COOLERS (AS SCHEDULED ON THE DRAWINGS)

- A. Water Coolers,: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-hanging fixture.
 - 1. Available Products:
 - 2. Products:
 - a) Elkay Manufacturing Co.
 - b) Halsey Taylor.
 - c) Haws Corporation.
 - d) Oasis Corp.

2.3 FIXTURE SUPPORTS

- A. Off-Floor, Plumbing Fixture Supports: ASME A112.6.1M, water-cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
 - 1. Available Manufacturers:
 - a) Josam Co.
 - b) Smith, Jay R. Mfg. Co.
 - c) Tyler Pipe; Wade Div.
 - d) Watts Industries, Inc.; Enpoco, Inc. Div.
 - e) Watts Industries, Inc.; Watts Drainage Products Div.
 - f) Zurn Specifications Drainage Operation.
 - 2. Type I: Hanger-type carrier with two vertical uprights.
 - 3. Type II: Bilevel, hanger-type carrier with three vertical uprights.
 - 4. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-hanging fixtures, unless otherwise indicated.
- B. Use mounting frames for recessed water coolers, unless otherwise indicated.
- C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-hanging fixtures, unless otherwise indicated.

- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- C. Install fixtures level and plumb.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Refer to Division 15 Section "Valves" for general-duty valves.
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for escutcheons.
- G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Water-Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water-cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

1.11. Section 15445 - Plumbing Specialties

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following plumbing specialties:
 - 1. Backflow preventers.
 - 2. Balancing valves.
 - 3. Key-operation hydrants.
 - 4. Drain valves.
 - 5. Miscellaneous piping specialties.
 - 6. Sleeve penetration systems.
 - 7. Flashing materials.
 - 8. Cleanouts.
 - 9. Floor drains.
- B. Related Sections include the following:
 - 1. Division 15 Section "Meters and Gages" for water meters, thermometers, and pressure gages.

1.2 DEFINITIONS

- A. The following are industry abbreviations for plastic piping materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. PE: Polyethylene plastic.
 - 3. PUR: Polyurethane plastic.
 - 4. PVC: Polyvinyl chloride plastic.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Piping: 125 psig.
 - 2. Sanitary Waste and Vent Piping: 10-foot head of water.
 - 3. Force-Main Piping: 100 psig.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:
 - 1. Backflow preventers and water regulators.

2. Balancing valves, water filters, and Strainers.
 3. Water hammer arresters, and air vents, and trap seal primer valves and systems.
 4. Drain valves, hose bibbs, and hydrants, and hose stations.
 5. Air-admittance valves, vent caps, vent terminals, and roof flashing assemblies.
 6. Sleeve penetration systems.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field test reports.
- D. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:
1. Backflow preventers and water regulators.
 2. Thermostatic water mixing valves and water tempering valves.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- E. NSF Compliance:
1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping.
 2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Operating Key Handles: Equal to 100 percent of amount installed for each key-operated hose bib and hydrant installed.

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

2.2 BACKFLOW PREVENTERS

- A. Manufacturers:
 - 1. Ames Co., Inc.
 - 2. Mueller Co.; Hersey Meters Div.
 - 3. Sparco, Inc.
 - 4. Watts Industries, Inc.; Water Products Div.
 - 5. Zurn Industries, Inc.; Wilkins Div.
- B. General: ASSE standard, backflow preventers.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. Interior Components: Corrosion-resistant materials.
 - 3. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
 - 4. Strainer: On inlet, if indicated.
- C. Pipe-Applied, Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.
- D. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with non-removable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

- E. Intermediate Atmospheric-Vent Backflow Preventers: ASSE 1012, suitable for continuous pressure application. Include inlet screen and two independent check valves with intermediate atmospheric vent.
- F. Hose-Connection Backflow Preventers: ASSE 1052, suitable for at least 3-gpm flow and applications with up to 10-foot head of water back pressure. Include two check valves; intermediate atmospheric vent; and non-removable, ASME B1.20.7, garden-hose threads on outlet.
- G. Back-Siphonage Backflow Vacuum Breakers: ASSE 1056, suitable for continuous pressure and backflow applications. Include shutoff valves, check valve, test cocks, and vacuum vent.

2.3 BALANCING VALVES

- A. Calibrated Balancing Valves: Adjustable, with two readout ports and memory setting indicator. Include manufacturer's standard hoses, fittings, valves, differential pressure meter, and carrying case.
 - 1. Manufacturers:
 - a) Amtrol, Inc.
 - b) Armstrong Pumps, Inc.
 - c) Armstrong-Yoshitake, Inc.
 - d) Flow Design, Inc.
 - e) ITT Industries; Bell & Gossett Div.
 - f) ROMAC Industries, Inc.; Hays Fluid Control Div.
 - g) Taco, Inc.
 - h) Tour & Andersson, Inc.
 - i) Watts Industries, Inc.; Water Products Div.
 - 2. NPS 2 and Smaller: Bronze body with brass ball, adjustment knob, calibrated nameplate, and threaded or solder-joint ends.

2.4 KEY-OPERATION HYDRANTS

- A. Manufacturers:
 - 1. Josam Co.
 - 2. Simmons Manufacturing Co.
 - 3. Smith, Jay R. Mfg. Co.
 - 4. Tyler Pipe; Wade Div.
 - 5. Watts Industries, Inc.; Drainage Products Div.
 - 6. Woodford Manufacturing Co.
 - 7. Zurn Industries, Inc.; Jonespec Div.
 - 8. Zurn Industries, Inc.; Specification Drainage Operation.
- B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.
 - 1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.

2. Outlet: ASME B1.20.7, garden-hose threads.
 3. Operating Keys: Two with each key-operation hydrant.
- C. Non-freeze Concealed-Outlet Wall Hydrants: ASSE 1019, self-drainable with flush-mounting box with cover, integral non-removable hose-connection vacuum breaker, casing and operating rod to match wall thickness, concealed outlet, and wall clamp.
1. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
 2. Box and Cover Finish: Rough bronze.
 3. Box and Cover Finish: Satin chrome plate.

2.5 DRAIN VALVES

- A. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.
1. Inlet: Threaded or solder joint.
 2. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.
- B. Hose-End Drain Valve: MSS SP-80, gate valve, Class 125, ASTM B 62 bronze body, with NPS 3/4 threaded or solder-joint inlet and ASME B1.20.7, garden-hose threads on outlet and cap. Hose bibbs are prohibited for this application.
- C. Stop-and-Waste Drain Valves: MSS SP-110, ball valve, rated for 200-psig minimum CWP or MSS SP-80, Class 125, gate valve; ASTM B 62 bronze body, with NPS 1/8 side drain outlet and cap.

2.6 MISCELLANEOUS PIPING SPECIALTIES

- A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, metal-bellows type with pressurized metal cushioning chamber. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F.
1. Manufacturers:
 - a) Josam Co.
 - b) Smith, Jay R. Mfg. Co.
 - c) Tyler Pipe; Wade Div.
 - d) Zurn Industries, Inc.; Specification Drainage Operation.
- B. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 1/2 or NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral or

field-installed, non-removable, drainable hose-connection vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.

1. Finish for Equipment Rooms: Rough bronze, or chrome or nickel-plated.
2. Finish for Service Areas: Rough bronze.

C. Air-Admittance Valves: Plastic housing with mechanical-operation sealing diaphragm, designed to admit air into drainage and vent piping and to prevent transmission of sewer gas into building.

1. Manufacturers:
 - a) B & K Industries, Inc.
 - b) Durgo, Inc.
 - c) IMI Cash Valve.
 - d) IPS Corporation.
 - e) J & B Products.
 - f) Magic Vent Co., Inc.
 - g) Oatey.
 - h) Sioux Chief Manufacturing Co., Inc.
 - i) Studor, Inc.
2. Stack Vent Valve: ASSE 1050, designed for installation as terminal on soil, waste, and vent stacks, instead of stack vent extending through roof, in NPS 2 to NPS 4.
3. Fixture Vent Valve: ASSE 1051, designed for installation on waste piping, instead of vent connection, for single fixture, in NPS 1-1/4 to NPS 2.

D. Open Drains: 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.

E. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.

F. Fixed Air-Gap Fittings: Manufactured cast-iron or bronze drainage fitting with semiopen top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

G. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

H. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and set-screws to secure to vent pipe.

- I. Vent Terminals: Commercially manufactured, shop- or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
- J. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing; of size and end types corresponding to connected piping.
- K. Downspout Boots: ASTM A 48, gray-iron casting, with NPS 4 outlet; shop-applied bituminous coating; and inlet size to match downspout.

2.7 SLEEVE PENETRATION SYSTEMS

- A. Manufacturers:
 - 1. ProSet Systems, Inc.
 - 2. Grace Construction Products
 - 3. Unique Fire Stop Products
- B. Description: UL 1479, through-penetration firestop assembly consisting of sleeve and stack fitting with firestopping plug.
 - 1. 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.
 - 2. Stack Fitting: ASTM A 48, gray-iron, hubless-pattern, wye-branch stack fitting with neoprene O-ring at base and gray-iron plug in thermal-release harness in branch. Include PVC protective cap for plug.
 - a) Special Coating: Include corrosion-resistant interior coating on fittings for plastic chemical waste and vent stacks.

2.8 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152, 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..
- 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.
- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.9 CLEANOUTS

- A. Cleanouts,: Comply with ASME A112.36.2M .
 - 1. Products:
 - a) Josam Co.
 - b) Sioux Chief Manufacturing Co., Inc.
 - c) Smith, Jay R. Mfg. Co.
 - d) Tyler Pipe, Wade Div.
 - e) Watts Industries, Inc., Drainage Products Div.
 - f) Zurn Industries, Inc., Jonespec Div.
 - 2. Body or Ferrule Material: Cast iron
 - 3. Closure: Brass plug with straight threads and gasket.
 - 4. Adjustable Housing Material: Cast iron with .
 - 5. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 - 6. Frame and Cover Shape: Round.
 - 7. Top Loading Classification: Light Duty.

2.10 FLOOR DRAINS

- A. Floor Drains: Comply with ASME A112.21.1M .
 - 1. Products:
 - a) Josam Co.
 - b) Smith, Jay R. Mfg. Co.
 - c) Tyler Pipe, Wade Div.
 - d) Watts Industries, Inc., Drainage Products Div.
 - e) Zurn Industries, Inc., Jonespec Div.
 - 2. Body Material: Gray iron.
 - 3. Seepage Flange: Required.
 - 4. Outlet: Bottom.
 - 5. Top or Strainer Material: Nickel bronze.
 - 6. Top Shape: Round.
 - 7. Top Loading Classification: Light Duty.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- C. Install 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.
- D. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
- E. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- F. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- G. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- H. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- I. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

- J. Fasten recessed-type plumbing specialties to reinforcement built into walls.
- K. Install wood-blocking reinforcement for wall mounting and recessed-type plumbing specialties.
- L. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Division 15 Section "Valves" for general-duty ball, butterfly, check, gate, and globe valves.
- M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipefittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect plumbing specialties to piping specified in other Division 15 Sections.
- D. Ground equipment.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- F. Connect plumbing specialties and devices that require power according to Division 16 Sections.

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. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
 - D. Secure flashing into sleeve and specialty clamping ring or device.
 - E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 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 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

1.12. Section 15452 - Sump Pumps

PART 1 – GENERAL

- A. This Section includes sump pumps for the building storm drainage systems.

1.2 SUBMITTALS

- A. Product Data: Include performance curves, furnished specialties, and accessories for each type and size of pump indicated.
- B. Maintenance Data: For each type and size of pump specified to include in maintenance manuals specified in Division 1.

1.3 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- 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.

1.4 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 rigging instructions for handling.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Submersible Sump Pumps:
 - a) Crane Pumps & Systems, Inc.; Weinman Div.
 - b) Federal Pump Corp.
 - c) Gorman-Rupp Co.
 - d) Goulds Pumps, Inc.

- e) Grundfos Pumps Corp.
- f) Liberty Pumps.
- g) Little Giant Pump Co.
- h) Metropolitan Pump Co.
- i) PACO Pumps, Inc.
- j) Stancor, Inc.
- k) Weil Pump Co.

2.2 SUBMERSIBLE SUMP PUMPS

- A. Description: Factory-assembled and -tested, single-stage, centrifugal, end-suction sump pump units complying with UL 778. Include motor, operating controls, and construction for permanent installation.
 - 1. Pump Arrangement: Duplex.
 - 2. Motors: Hermetically sealed, air-filled, with permanently-lubricated ball bearings, and non-overloading through full range of pump performance curves.
 - 3. Discharge Pipe End Connections NPS 2 and Smaller: Threaded. Pumps available only with flanged-end discharge pipe may be furnished with threaded companion flanges.
 - 4. Casing: Cast iron with cast-iron inlet strainer, legs that elevate pump to permit flow into impeller, and discharge companion flange suitable for plain-end pipe connection arranged for vertical discharge.
 - 5. Impeller: ASTM A 48, Class No. 25 A or higher cast iron; statically and dynamically balanced, open or semiopen non-clog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
 - 6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
 - 7. Seals: Single, ceramic face, mechanical seal.
 - 8. Controls: NEMA Type 4X enclosure, pedestal mounted, unless wall mounting is indicated; three mechanical-float switches; mounting rod; and electric cables.
 - a) Float-Guide Pipe: Guide pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - b) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.
- B. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2.3 SUMP PUMP BASINS

- A. Description: Factory fabricated with sump, pipe connections, and separate cover.
- B. Basin Sump: Fabricate watertight, with sidewall openings for pipe connections.
 - 1. Material: Fiberglass, polyethylene, steel with bitumastic coating, or cast iron.
 - 2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
 - 3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- C. Basin Cover: Fabricate with openings with gaskets, seals, and bushings, for access, pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
 - 1. Material: Steel with bitumastic coating, or cast iron.
 - 2. Reinforcement: Steel or cast-iron reinforcement capable of supporting foot traffic for basins installed in foot-traffic areas.

2.4 SUMP PUMP PITS

- A. Description: Cast-in-place concrete with steel curb frames and covers. Refer to Division 3 Section "Cast-in Place Concrete."
- B. Curb Frames: Galvanized steel or steel with bitumastic coating of dimension to fit cover.
 - 1. Pattern: Angle-cross-section shape with flat top surface.
- C. Pit Cover: Fabricate with openings with gaskets, seals, and bushings, for access, pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

2.5 GENERAL-DUTY VALVES

- A. Refer to Division 15 Section "Valves" for general-duty gate, ball, butterfly, globe, and check valves. Use valves specified for domestic water, unless otherwise indicated. Include features and devices indicated.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of plumbing piping systems to verify actual locations of piping connections before pump installation.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.3 CONCRETE

- A. Install concrete bases of dimensions indicated for sump pumps. Refer to Division 3 Section "Cast-in-Place Concrete" and Division 15 Section "Basic Mechanical Materials and Methods."
- B. Concrete for pits and sumps is specified in Division 3 Section "Cast-in-Place Concrete."

3.4 INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
- B. Install pumps and arrange to provide access for maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support piping so weight of piping is not supported by pumps.
- D. Submersible Sump Pumps: Set pumps on basin, pit, or sump floor. Make direct connections to storm drainage piping.
- E. Sump Pump Basins: Install basins and connect to storm drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install so top surface of cover is flush with finished floor.
- F. Sump Pump Pits: Construct concrete pits and connect to storm drainage piping. Refer to Division 3 Section "Cast-in-Place Concrete" for concrete work. Set basin cover and fasten to top edge of concrete pit. Install so top surface of cover is flush with finished floor.

3.5 CONNECTIONS

- A. Storm drainage piping installation requirements are specified in Division 15 Section "Drainage and Vent Piping." Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
 - 1. Install discharge pipe sizes equal to or greater than diameter of pump nozzles, and connect to storm drainage piping.
 - 2. Install swing check valve and gate or ball valve on each sump pump discharge. Include spring-loaded or weighted-lever check valves for piping NPS 2-1/2 and larger.

- B. Install electrical connections for power, controls, and devices.
- C. Electrical power and control components, wiring, and connections are specified in Division 16 Sections.
- D. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B

3.6 ADJUSTING

- A. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.

3.7 COMMISSIONING

- A. Final Checks before Starting: Perform the following preventive maintenance operations:
 - 1. Lubricate bearings.
 - 2. Disconnect couplings and check motors for proper direction of rotation.
 - 3. Verify that each pump is free to rotate by hand. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.
 - 4. Verify that pump controls are correct for required application.
- B. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
 - 1. Start motors.
 - 2. Open discharge valves slowly.
 - 3. Check general mechanical operation of pumps and motors.

END OF SECTION

1.13. Section 15460 - Electric, Domestic Water Heaters

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following for domestic water systems:
 - 1. Commercial, electric water heaters.
 - 2. Compression tanks.
 - 3. Accessories.

1.2 SUBMITTALS

- A. Product Data: For each type and size of water heater. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Shop Drawings: Detail water heater assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- C. Product Certificates: Signed by manufacturers of water heaters certifying that products furnished comply with requirements.
- D. Maintenance Data: For water heaters to include in maintenance manuals specified in Division 1.
- E. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on specific units indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 1 Section "Substitutions."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- D. ASME Compliance: Fabricate and label water heater, hot-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division.
- E. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:
 - 1. ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," for commercial water heaters.

1.4 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include heating elements and storage tanks.
 - 2. Warranty Period: From date of Substantial Completion:
 - a) Heating Elements: Five years.
 - b) Storage Tanks: 10 years.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Light-Commercial, Storage, Electric Water Heaters:
 - a) American Water Heater Co.
 - b) Bradford White Corp.
 - c) Electric Heater Corp.
 - d) Lochinvar Corp.
 - e) Patterson-Kelley Co.
 - f) Rheem Manufacturing Co.; Rheem Water Heater Div.
 - g) Rheem Manufacturing Co.; Ruud Water Heater Div.
 - h) Smith: A. O. Smith Water Products Co.
 - 2. Water Heater Stand and Drain Pan Units:
 - a) Safety: W. H. Safety Products, Inc.
 - b) Hubbard Enterprises Holdrite
 - c) Water-Tite
 - 3. Compression Tanks:
 - a) Amtrol, Inc.
 - b) Armstrong Pumps, Inc.

- c) Myers: F. E. Myers.
- d) Smith: A. O. Smith; Aqua-Air Div.
- e) State Industries.
- f) Taco, Inc.
- g) Wessels Co.
- h) Zurn Industries, Inc.; Wilkins Div.

2.2 LIGHT-COMMERCIAL, STORAGE, ELECTRIC WATER HEATERS

- A. Description: Comply with UL 174 or UL 1453, and listed by manufacturer for commercial applications.
- B. Storage Tank Construction: ASME-code Ssteel with 150-psig working-pressure rating.
 - 1. Tappings: Factory fabricated of materials compatible with tank for piping connections, relief valve, pressure gage, thermometer, drain, anode rod, and controls as required. Attach tappings to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
 - 2. Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
 - 3. Insulation: Comply with ASHRAE 90.1. Surround entire storage tank except connections and controls.
 - 4. Jacket: Steel, with enameled finish.
- C. Heating Elements: Two electric, screw-in, immersion type.
 - 1. Temperature Control: Adjustable thermostat for each element with wiring arrangement for simultaneous operation.
 - 2. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
- D. Drain Valve: ASSE 1005, corrosion-resistant metal, factory installed.
- E. Anode Rod: Factory installed, magnesium.
- F. Dip Tube: Factory installed. Not required if cold-water inlet is near bottom of storage tank.
- G. Special Requirement: NSF 5 construction.

2.3 COMPRESSION TANKS

- A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

- B. Construction: 150-psig working-pressure rating.
- C. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
- D. Tank Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
- E. Tank Exterior Finish: Manufacturer's standard, unless finish is indicated.
- F. Air-Charging Valve: Factory installed.

2.4 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.
 - 1. Option: Separate temperature and pressure relief valves are acceptable instead of combination relief valve.
 - 2. Exception: Omit combination temperature and pressure relief valve for tankless water heater, and furnish pressure relief valve for installation in piping.
- B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than heat-exchanger working-pressure rating.
- C. Vacuum Relief Valves: Comply with ASME PTC 25.3. Furnish for installation in piping.
 - 1. Exception: Omit if water heater has integral vacuum-relieving device.
- D. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig-maximum outlet pressure.
- E. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.
- F. Water Heater Stands: Water heater manufacturer's factory-fabricated, steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.
- G. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated, steel bracket for wall mounting and capable of supporting water heater and water.

- H. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE 90.1 or ASHRAE 90.2.

PART 3 – EXECUTION

3.1 CONCRETE BASES

- A. Install concrete bases of dimensions indicated. Refer to Division 3 Section "Cast-in-Place Concrete" and Division 15 Section "Basic Mechanical Materials and Methods."

3.2 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete bases.
 - 1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
- B. Install water heaters, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Anchor water heaters to substrate.
- D. Install temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.
- E. Install water heater drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 15 Section "Plumbing Specialties" for drain valves.
- F. Install thermometers on water heater inlet and outlet piping. Refer to Division 15 Section "Meters and Gages" for thermometers.
 - 1. Exception: Omit thermometers for the following:
 - a) Light-commercial, water heater inlet piping.
 - b) Water heater with thermometer outlet piping.
- G. Install pressure gages on water heater piping. Refer to Division 15 Section "Meters and Gages" for pressure gages.
- H. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through

each water heater. Include shutoff valve, and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 15 Section "Valves" for general-duty valves and Division 15 Section "Meters and Gages" for thermometers.

- I. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.
- J. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- K. Fill water heaters with water.
- L. Charge compression tanks with air.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union.
- D. Make connections with dielectric fittings where piping is made of dissimilar metal.
- E. Electrical Connections: Power wiring and disconnect switches are specified in Division 16 Sections. Arrange wiring to allow unit service.
- F. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.
- B. In addition to manufacturer's written installation and startup checks, perform the following:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Verify that piping system tests are complete.
 - 3. Check for piping connection leaks.
 - 4. Check for clear relief valve inlets, outlets, and drain piping.
 - 5. Check operation of circulators.
 - 6. Test operation of safety controls, relief valves, and devices.
 - 7. Energize electric circuits.
 - 8. Adjust operating controls.

9. Adjust hot-water-outlet temperature settings. Do not set above 120 deg F unless piping system application requires higher temperature.

END OF SECTION 15460

40. SWEF Building, Heating and Ventilating, Item SPV.0105.13

A Description

This item consists of the HVAC work for the SWEF building. The work shall be in accordance with the applicable plans and the following specifications.

B Measurement

The department will measure SWEF Building, Heating and Ventilating, completed in accordance to the contract and accepted, as a single complete unit of work.

C Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.13	SWEF Building, Heating and Ventilating	LS

Payment shall be full compensation for furnishing all materials and equipment; and for supplying all labor, tools, equipment, and incidentals necessary to complete the work.

1.1. Section 15500 - Basic HVAC Materials And Methods

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Grout.
 - 6. Equipment installation requirements common to equipment sections.
 - 7. Painting and finishing.
 - 8. Concrete bases.

1.2 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, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.

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

1.3 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 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.

1.5 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.
- D. Sequence, coordinate, and integrate installing mechanical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

- E. Where mechanical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Coordination Meetings: Attend coordination meetings with the construction manager and all other trades for the purpose of coordinating the locations of all fire protection, plumbing, HVAC and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field.
- G. Coordination Drawings: Each fire protection, plumbing, HVAC and electrical contractor shall develop ¼" scale coordination drawings for all of their respective working areas that necessitate additional coordination to allow for efficient systems installation. Each coordination drawing, for all trades, shall be signed and dated by each trade indicating that each trade has fully coordinated their work
- H. Conflicts Between Trades: Resolve all conflicts with trades at no additional cost to the Owner or Architect.
- I. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of fire protection, HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.
- J. Ceiling Grid Priority: Lighting fixture and sprinkler head locations take priority over diffuser and grille locations.

1.6 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. These specifications and attendant drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with present practices of the trade shall not relieve the Contractor from providing such additional labor and materials.
- B. The drawings depicting mechanical work are diagrammatic and show, in their approximate location, symbols representing mechanical equipment and devices. The exact location of such equipment and devices shall be established in the field in accordance with instructions from the Architect and/or established by manufacturer's installation drawings and details.
 - 1. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring mechanical connections to verify rough-in and connection locations.

2. Unless specifically stated to the contrary, no measurement of a mechanical drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the mechanical drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual fabrication and installation of equipment.

1.7 DRAWINGS

- A. The mechanical drawings do not attempt to show the complete details of building construction which affect the mechanical installation. The Contractor shall refer to the architectural, civil, structural, plumbing and electrical drawings for additional details which affect the proper installation of this work. Bring any discrepancies to the attention of the A/E for resolution. The Contractor is cautioned that diagrams showing mechanical connections, ductwork, and/or piping are diagrammatic only and must not be used for obtaining lineal runs of duct or piping. Duct and piping diagrams do not necessarily show the exact physical arrangement of the equipment.
- B. The Engineer will make available to the contractor electronic copies of plan sheets. Electronic copies of plan sheets requested will be delivered via email or US Postal Service for the cost of \$20 per plan sheet plus \$50. Any requests shall be made in writing to the Engineer with a certified check or money order payable to the Engineer. The files will be sent out within 7 days of receipt of the request and payment in full.
 1. The file format of the plans will be as provided by the software used to develop the plans. The files will not be converted to other formats.

1.8 MATERIAL AND EQUIPMENT

- A. All material and equipment shall be new and of the quality used for the purpose in good commercial practice, and shall be standard product of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, catalog number, and capacity or rating on a nameplate, securely affixed on the equipment in a conspicuous place.
- B. Project design is based around the first listed manufacturer in relative specification sections. Subsequent manufacturer or equals listed are also acceptable. However, the use of these manufacturers may result in minor design changes involving layout, supports, electrical requirements, etc. The Contractor shall be responsible for such and include any modifications required as part of his bid.

1.9 DAMAGE TO OTHER WORK

- A. The Mechanical Contractor will be held rigidly responsible for all damages to the work of his own or any other trade resulting from the execution of his work. It shall be the Contractor's responsibility to adequately protect his work at all times. All damages resulting from his operations shall be repaired or the damaged portions replaced by the party originally performing the work, (to the entire satisfaction of the Architect), and all cost thereof shall be borne by the Contractor responsible for the damage.

1.10 COOPERATION WITH OTHER TRADES

- A. This Contractor shall completely cooperate with all other trades in the matter of planning and executing of the work. Every reasonable effort shall be made to prevent conflict and interferences as to space requirements, dimensions, locations, openings, sleeving or other matters which tend to delay or obstruct the work of any trade.

1.11 NEGLIGENCE

- A. Should the Contractor fail to provide materials, templates, etc., or other necessary information causing delay or expense to another party, he shall pay the actual amount of the damages to the party who sustained the loss.

1.12 FIELD CHANGES

- A. Should any change in drawings or specifications be required to comply with local regulations and/or field conditions, the Contractor shall refer same to Architect for approval before any work which deviates from the original requirements of the drawings and specifications is started. In the event of disagreements as to the necessity of such changes, the decision of the Architect shall be final.

1.13 CUTTING AND PATCHING

- A. As necessary and with approval to permit the installation of any part of the work under this branch. Any cost caused by defective or ill-timed work shall be by the party responsible therefore. Patching of holes, openings, etc. resulting from the work of this branch shall be furnished by this Contractor.

1.14 STANDARDS, CODES AND PERMITS

- A. All work shall be installed in accordance with National, State and Local codes, laws, ordinances and regulations. Comply with all applicable OSHA regulations.
- B. All materials shall have a U.L. label where a U.L. standard and/or test exists.

- C. Prepare and submit to all authorities having jurisdiction, for their approval, all applications and working drawings required by them. Secure and pay for all permits and licenses required.

1.15 CLEAN-UP

- A. This Contractor shall at all times keep the premises free from excessive accumulation of waste material or rubbish resulting from his work, including tools, scaffolding and surplus materials, and he shall leave his work broom-clean or its equivalent. In case of disputes, the Architect may order the removal of such rubbish and charge the cost to the responsible contractor as determined by the Architect. At the time of final clean-up all fixtures and equipment shall be thoroughly cleaned and left in proper condition for their intended use.

1.16 DRAWINGS OF OTHER TRADES

- A. The Contractor shall consult the drawings of the work for the various other trades; field layouts of the parties performing the work of the other trades; their shop drawings, and he shall be governed accordingly in laying out his work.

1.17 FIELD MEASUREMENTS

- A. The Contractor shall take all field measurements necessary for his work and shall assume the full responsibility for their accuracy.

1.18 STRUCTURAL INTERFERENCES

- A. Should any structural interferences prevent the installation of the mechanical work at points shown on drawings, the necessary minor deviations therefrom, as determined by the Architect, may be permitted. Minor changes in the position of the equipment if decided upon before any work has been done by the Contractor shall be made without additional charge.

1.19 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

- A. Before submitting a bid, the Contractor shall familiarize himself with all features of the building and site which may affect the execution of his work. No extra payment will be allowed for the failure to obtain this information. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points with the Architect before submitting his bid. In lieu of written clarification by addendum, resolve all conflicts in favor of the greater quantity or better quality.
- B. The Contractor shall be responsible for all existing field conditions. Review existing field conditions prior to bid and shall take into account in bid proposal.

No additional compensation will be allowed due to Contractor's failure to include all necessary work in the bid proposal.

1.20 GUARANTEE

- A. The Contractor shall unconditionally guarantee his work and all components thereof, excluding filters, for a period of one year from the date of his final payment. He shall remedy any defects in workmanship and repair or replace any faulty equipment which shall appear within the guarantee period to the entire satisfaction of the Architect at no additional charge.

1.21 SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN

- A. Such requests shall be accompanied by three copies of all necessary illustrations, cuts, drawings and descriptions of material proposed for substitution and shall fully describe all points in which it differs from the articles specified. The Engineer will retain two copies and one copy returned to the Contractor with acceptance, rejection or revisions indicated thereon.
- B. The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.
- C. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs, including architectural/engineering design and construction costs, involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- D. All substitution review costs shall be reimbursed to the Engineer by the contractor or their suppliers on a Time/Material bases. This cost shall be paid on approval or disapproval of the substitution material, equipment or design.

1.22 SUBMITTALS

- A. Submit to Engineer for review, copies of manufacturer's shop drawings and/or equipment data sheets as indicated in this specification.
 - 1. Shop drawings shall be submitted in advance of construction and installation so as to not cause delay in other Contractor's work and to allow for Architect/Engineer's review. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment.
 - 2. All submittals required by each section shall be submitted together, bound in one three-ring binder with each item tabbed separately.
 - 3. Shop drawings shall bear the Contractor's stamp indicating approval.

4. Fabrication, purchase or installation of any fixture, equipment or material requiring submittal review prior to Engineer's review shall be at the Contractor's risk.
5. Any shop drawing not meeting the requirements as outlined in this or any other part of this specification or drawing, requiring more than two reviews shall have a fee of reimbursement to the Engineer by the contractor or their suppliers. Fee shall be calculated on a Time & Material basis, and shall be paid prior to the release of the reviewed submittals.

1.23 WORKMANSHIP

- A. The installation of all work shall be made so that its several component parts will function as a workable system complete with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The work shall be executed in conformity with the best-accepted standard practice of the trade so as to contribute to efficiency and appearance. It shall also be executed so that the installation will conform and adjust itself to the building structure, its equipment and its usage.

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 15 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 15 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. 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 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a) Central Plastics Company.
 - b) Eclipse, Inc.
 - c) Watts Industries, Inc.; Water Products Div.
 - d) Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a) Central Plastics Company.
 - b) Epco Sales, Inc.
 - c) Watts Industries, Inc.; Water Products Div.

- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a) Advance Products & Systems, Inc.
 - b) Calpico, Inc.
 - c) Central Plastics Company.
 - d) Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a) Calpico, Inc.
 - b) Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a) Perfection Corp.
 - b) Precision Plumbing Products, Inc.
 - c) Sioux Chief Manufacturing Co., Inc.
 - d) Victaulic Co. of America.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.

- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, 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 SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 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. Sleeves are not required for core-drilled holes.
- M. Permanent sleeves are not required for holes formed by removable PE sleeves.
- N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a) PVC or Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
- Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop

materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. 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.
- I. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- J. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- K. 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.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.

- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

1.2. Section 15506 - Mechanical Hangers And Supports

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following hangers and supports for mechanical system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
- B. Related Sections include the following:
 - 1. Division 15 Section(s) "Metal Ducts " for duct hangers and supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. B-Line Systems, Inc.; a division of Cooper Industries.
 - 3. Carpenter & Paterson, Inc.
 - 4. Empire Industries, Inc.
 - 5. ERICO/Michigan Hanger Co.
 - 6. Globe Pipe Hanger Products, Inc.
 - 7. Grinnell Corp.
 - 8. GS Metals Corp.
 - 9. National Pipe Hanger Corporation.
 - 10. Piping Technology & Products, Inc.
- C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.

- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a) B-Line Systems, Inc.; a division of Cooper Industries.
 - b) Empire Industries, Inc.
 - c) Hilti, Inc.
 - d) ITW Ramset/Red Head.
 - e) MKT Fastening, LLC.
 - f) Powers Fasteners.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 – EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. 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. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 4. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 5. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 7. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 9. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
 10. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 11. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
- F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- G. 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. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- H. 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.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. 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.
- I. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- K. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c) Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 3. 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.
 - 4. Insert Material: Length at least as long as protective shield.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers .
- B. Fit exposed connections together to form hairline joints.

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. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

1.3. Section 15508 - Mechanical Identification

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Equipment markers.
 - 3. Equipment signs.
 - 4. Access panel and door markers.
 - 5. Pipe markers.
 - 6. Duct markers.
 - 7. Stencils.
 - 8. Valve tags.
 - 9. Valve schedules.
 - 10. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 – PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a) Manufacturer, product name, model number, and serial number.
 - b) Capacity, operating and power characteristics, and essential data.
 - c) Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Data:
 - a) Name and plan number.
 - b) Equipment service.
 - c) Design capacity.
 - d) Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 - 3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Data: Instructions for operation of equipment and for safety procedures.
 - 2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
 - 3. Thickness: 1/16 inch, unless otherwise indicated.
 - 4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

- D. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
 - 1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 - 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 - 4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.
 - 1. Stencil Material: Metal or fiberboard.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel, black, unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1, unless otherwise indicated.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.
 1. Material: 0.032-inch- thick brass.
 2. Material: 3/32-inch- thick laminated plastic with 2 black surfaces and white inner layer.
 3. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.5 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 2. Frame: Extruded aluminum.
 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 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 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 4. Fans, blowers, primary balancing dampers, and mixing boxes.
 5. Packaged HVAC central-station and zone-type units.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a) Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b) Fire department hose valves and hose stations.
 - c) Meters, gages, thermometers, and similar units.
 - d) Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 - e) Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - f) Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 - g) Fans, blowers, primary balancing dampers, and mixing boxes.
 - h) Packaged HVAC central-station and zone-type units.
 - i) Tanks and pressure vessels.
 - j) Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- C. Stenciled Equipment Marker Option: Stenciled markers may be provided instead of laminated-plastic equipment markers, at Installer's option, if lettering larger

than 1 inch high is needed for proper identification because of distance from normal location of required identification.

- D. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
 - 1. Identify mechanical equipment with equipment markers in the following color codes:
 - a) Green: For cooling equipment and components.
 - b) Yellow: For heating equipment and components.
 - c) Orange: For combination cooling and heating equipment and components.
 - d) Brown: For energy-reclamation equipment and components.
 - 2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 4. Include signs for the following general categories of equipment:
 - a) Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b) Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 - c) Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - d) Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 - e) Fans, blowers, primary balancing dampers, and mixing boxes.
 - f) Packaged HVAC central-station and zone-type units.
 - g) Tanks and pressure vessels.
 - h) Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- E. Stenciled Equipment Sign Option: Stenciled signs may be provided instead of laminated-plastic equipment signs, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- F. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
 2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, [at least 3/4 inch] [1-1/2 inches] wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Stenciled Pipe Marker Option: Stenciled markers may be provided instead of manufactured pipe markers, at Installer's option. Install stenciled pipe markers with painted, color-coded bands or rectangles on each piping system.
1. Identification Paint: Use for contrasting background.
 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
 - 1. Valve-Tag Size and Shape:
 - a) Heat Pump supply and return: 1-1/2 inches, round
 - 2. Valve-Tag Color:
 - a) Heat Pump supply and return: Natural.
 - 3. Letter Color:
 - a) Heat Pump supply and return: White.

3.5 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

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

3.7 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION

1.4. Section 15510 - Duct Insulation

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes semirigid and flexible duct, plenum, and breeching insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 15 Section "Pipe Insulation" for insulation for piping systems.
 - 2. Division 15 Section "Metal Ducts" for duct liner.

1.2 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate clearance requirements with duct Installer for insulation application.

1.6 SCHEDULING

- A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a) CertainTeed Manson.
 - b) Johns Manville
 - c) Knauf FiberGlass GmbH.
 - d) Owens-Corning Fiberglas Corp.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

2.3 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..
 - 1. Tape Width: 4 inches.
- B. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized steel washer. Pin length sufficient for insulation thickness indicated.
 - 1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.

2.4 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- F. Keep insulation materials dry during application and finishing.
- G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation with the least number of joints practical.
- I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder

mastic. Apply insulation continuously through hangers and around anchor attachments.

- K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- L. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
 - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.
 - 1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
 - 2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.
- O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Seal insulation to roof flashing with vapor-retarder mastic.
- P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- Q. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.
- R. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
 - 1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a) On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b) On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c) Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d) Do not overcompress insulation during installation.
 4. Impale insulation over anchors and attach speed washers.
 5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
 7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
 8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
 10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
- B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Space anchor pins as follows:
 - a) On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b) On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c) Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d) Do not overcompress insulation during installation.
4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
 1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of jacket manufacturer's recommended adhesive.
 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.6 DUCT SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.
- C. Insulate the following plenums and duct systems:
 - 1. Indoor concealed supply- and outside-air ductwork.
 - 2. Indoor exposed supply- and outside-air ductwork.
- D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Testing agency labels and stamps.
 - 8. Nameplates and data plates.
 - 9. Access panels and doors in air-distribution systems.

3.7 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

- A. Service: Supply-air ducts, concealed and exposed in equipment rooms.
 - 1. Material: Mineral-fiber board or mineral-fiber blanket with factory supplied FSK jacket .
 - 2. Thickness: 1-1/2 inches.
 - 3. Number of Layers: One.
 - 4. Field-Applied Jacket: None.
 - 5. Vapor Retarder Required: Yes.
- B. Service: Outside-air ducts, concealed.
 - 1. Material: Mineral-fiber board or mineral-fiber blanket with factory supplied FSK jacket.
 - 2. Thickness: 1-1/2 inches each.
 - 3. Number of Layers: Two.
 - 4. Field-Applied Jacket: None.
 - 5. Vapor Retarder Required: Yes.
- C. Service: Round, supply-air ducts, exposed in occupied spaces.
 - 1. No insulation required.

- D. Service: Round, supply-air ducts, exposed in unoccupied spaces.
 - 1. Material: Mineral-fiber blanket with factory supplied FSK jackets .
 - 2. Thickness: 1-1/2 inches.
 - 3. Number of Layers: One.
 - 4. Field-Applied Jacket: None.
 - 5. Vapor Retarder Required: Yes.

- E. Service: Outside-air ducts, exposed.
 - 1. Material: Mineral-fiber board w/ factory supplied FSK Jackets.
 - 2. Thickness: 2 inches.
 - 3. Number of Layers: One.
 - 4. Field-Applied Jacket: None.
 - 5. Vapor Retarder Required: Yes.

END OF SECTION

1.5. Section 15512 - HVAC Pipe Insulation

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 15 Section "Duct Insulation" for insulation for ducts and plenums.
 - 2. Division 15 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.2 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

1.3 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for insulation application.

1.4 SCHEDULING

- A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a) CertainTeed Manson.
 - b) Knauf FiberGlass GmbH.
 - c) Owens-Corning Fiberglas Corp.
 - d) Johns Manville

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 - 2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
 - 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a) Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b) Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 - 4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 - 5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 - 6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
 - 7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- C. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - 2. Adhesive: As recommended by insulation material manufacturer.

2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..
 - 1. Tape Width: 4 inches.
- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 - 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.

2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a) Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
1. Seal penetrations with vapor-retarder mastic.
 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
- T. Floor Penetrations: Apply insulation continuously through floor assembly.
1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.

2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with standard PVC fitting covers.
- D. Apply insulation to valves and specialties as follows:
1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When pre-molded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

3.5 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
 - 1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch- thick coats of jacket manufacturer's recommended adhesive.
 - 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
- B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.
 - 1. Draw jacket material smooth and tight.
 - 2. Apply lap or joint strips with the same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.
- C. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

3.6 FINISHES

- A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting."
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.7 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Flexible connectors.
 - 2. Vibration-control devices.
 - 3. Fire-suppression piping.
 - 4. Drainage piping located in crawl spaces, unless otherwise indicated.
 - 5. Below-grade piping, unless otherwise indicated.

6. Chrome-plated pipes and fittings, unless potential for personnel injury.
7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.8 FIELD QUALITY CONTROL

- A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
 1. Inspect fittings and valves randomly selected by Architect.
 2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
 3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.
- B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.
- C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.9 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.10 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Ground Source supply and return.
 1. Operating Temperature: 35 to 75 deg F.
 2. Insulation Material: Mineral fiber.
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a) Steel or copper pipe, NPS 1 and smaller: 1/2-inch minimum.
 - b) Steel or copper pipe, NPS 1-1/4 through NPS 2: 3/4-inch minimum.
 4. Field-Applied Jacket: PVC Aluminum Stainless steel None.
 5. Vapor Retarder Required: Yes.
 6. Finish: Painted.

END OF SECTION

1.6. Section 15520 - HVAC Valves

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Copper-alloy ball valves.
 - 2. Bronze check valves.
 - 3. Bronze globe valves.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical Identification" for valve tags and charts.
 - 2. Division 15 Section "HVAC Instrumentation and Controls" for control valves and actuators.

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. SWP: Steam working pressure.
 - 6. 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: ASME B31.9 for building services piping valves.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping and storage as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Block check valves in either closed or open position.

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 2 and smaller with threaded ends, unless otherwise indicated.
- C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- E. Valve Actuators:
 - 1. Handwheel: For valves other than quarter-turn types.
 - 2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
 - 3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
- F. Extended Valve Stems: On insulated valves.
- G. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- H. Valve Grooved Ends: AWWA C606.
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - a) Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

2. Threaded: With threads according to ASME B1.20.1.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:
 - a) Grinnell Corporation.
 - b) Milwaukee Valve Company.
 - c) NIBCO INC.
 - d) Red-White Valve Corp.
 - e) Watts Industries, Inc.; Water Products Div.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Bronze body with full -port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.4 BRONZE CHECK VALVES

A. Manufacturers:

1. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:
 - a) Cincinnati Valve Co.
 - b) Crane Co.; Crane Valve Group; Crane Valves.
 - c) Crane Co.; Crane Valve Group; Jenkins Valves.
 - d) Red-White Valve Corp.
2. Type 2, Bronze, Vertical Lift Check Valves with Nonmetallic Disc:
 - a) Grinnell Corporation.
 - b) Kitz Corporation of America.
 - c) Milwaukee Valve Company.
3. Type 3, Bronze, Swing Check Valves with Metal Disc:
 - a) American Valve, Inc.
 - b) Cincinnati Valve Co.
 - c) Crane Co.; Crane Valve Group; Crane Valves.
 - d) Crane Co.; Crane Valve Group; Jenkins Valves.
 - e) Crane Co.; Crane Valve Group; Stockham Div.
 - f) Grinnell Corporation.
 - g) Hammond Valve.
 - h) Kitz Corporation of America.
 - i) Legend Valve & Fitting, Inc.
 - j) Milwaukee Valve Company.
 - k) NIBCO INC.
 - l) Powell, Wm. Co.
 - m) Red-White Valve Corp.

- n) Walworth Co.
 - o) Watts Industries, Inc.; Water Products Div.
- 4. Type 4, Bronze, Swing Check Valves with Nonmetallic Disc:
 - a) Cincinnati Valve Co.
 - 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) Grinnell Corporation.
 - f) Hammond Valve.
 - g) McWane, Inc.; Kennedy Valve Div.
 - h) Milwaukee Valve Company.
 - i) NIBCO INC.
 - j) Red-White Valve Corp.
 - k) Walworth Co.
 - l) Watts Industries, Inc.; Water Products Div.
- B. Bronze Check Valves, General: MSS SP-80.
- C. Type 1, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.
- D. Type 2, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.
- E. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.
- F. Type 4, Class 125, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.5 CAST-IRON GATE VALVES

- A. Manufacturers:
 - 1. Type I, Cast-Iron, Rising-Stem Gate Valves:
 - a) Grinnell Corporation.
 - b) Milwaukee Valve Company.
 - c) NIBCO INC.
 - d) Red-White Valve Corp.
 - e) Watts Industries, Inc.; Water Products Div.
- B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.
- C. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

2.6 BRONZE GLOBE VALVES

A. Manufacturers:

1. Type 1, Bronze Globe Valves with Metal Disc:
 - a) Cincinnati Valve Co.
 - 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) Grinnell Corporation.
 - f) Hammond Valve.
 - g) Kitz Corporation of America.
 - h) Legend Valve & Fitting, Inc.
 - i) Milwaukee Valve Company.
 - j) NIBCO INC.
 - k) Powell, Wm. Co.
 - l) Red-White Valve Corp.
 - m) Walworth Co.
2. Type 2, Bronze Globe Valves with Nonmetallic Disc:
 - a) Cincinnati Valve Co.
 - 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) Grinnell Corporation.
 - f) Hammond Valve.
 - g) Kitz Corporation of America.
 - h) McWane, Inc.; Kennedy Valve Div.
 - i) Milwaukee Valve Company.
 - j) NIBCO INC.
 - k) Powell, Wm. Co.
 - l) Red-White Valve Corp.
 - m) Walworth Co.
3. Type 3, Bronze Globe Valves with Renewable Seat and Metal Disc:
 - a) Cincinnati Valve Co.
 - 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) Grinnell Corporation.
 - f) Hammond Valve.
 - g) Milwaukee Valve Company.
 - h) NIBCO INC.
 - i) Walworth Co.

B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy handwheel.

C. Type 1, Class 125, Bronze Globe Valves: Bronze body with bronze disc and union-ring bonnet.

- D. Type 2, Class 125, Bronze Globe Valves: Bronze body with nonmetallic disc and union-ring bonnet.
- E. Type 3, Class 125, Bronze Globe Valves: Bronze body with bronze disc and renewable seat. Include union-ring bonnet.

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: Ball valves.
 - 2. Throttling Service: Ball or globe valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Condenser Water Water Source Heat Pump Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two -piece, 600-psig CWP rating, copper alloy.
2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
3. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum .
4. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, OS&Y, bronze-mounted cast iron.
5. Globe Valves, NPS 2 and Smaller: Type 2, Class 125 , bronze.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 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 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 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. 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 15520

1.7. Section 15522 - HVAC Meters And Gages

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following meters and gages for mechanical systems:
 - 1. Thermometers.
 - 2. Gages.
 - 3. Test plugs.

1.2 DEFINITIONS

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

1.3 SUBMITTALS

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

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 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Manufacturers:
 - 1. Palmer - Wahl Instruments Inc.
 - 2. Weiss Instruments, Inc.
 - 3. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Chrome-plated brass, 9 inches long.
- C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

- E. Window: Glass.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 THERMOWELLS

- A. Manufacturers:
 - 1. AMETEK, Inc.; U.S. Gauge Div.
 - 2. Miljoco Corp.
 - 3. Weiss Instruments, Inc.
 - 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
 - 5. Winters Instruments.
- B. Manufacturers: Same as manufacturer of thermometer being used.
- C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES

- A. Manufacturers:
 - 1. AMETEK, Inc.; U.S. Gauge Div.
 - 2. Miljoco Corp.
 - 3. Weiss Instruments, Inc.
 - 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
 - 5. Winters Instruments.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 - 1. Case: Dry type, metal or plastic, 4-1/2-inch diameter.
 - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 - 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
 - 4. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 - 6. Pointer: Red metal.
 - 7. Window: Glass.

8. Ring: Metal.
 9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
 11. Range for Fluids under Pressure: Two times operating pressure.
- C. Pressure-Gage Fittings:
1. Valves: NPS 1/4 brass or stainless-steel needle type.
 2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
 3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 TEST PLUGS

- A. Manufacturers:
1. Flow Design, Inc.
 2. MG Piping Products Co.
 3. National Meter, Inc.
 4. Peterson Equipment Co., Inc.
 5. Sisco Manufacturing Co.
 6. Watts Industries, Inc.; Water Products Div.
- B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- D. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
 2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 – EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install liquid-in-glass thermometers in the following locations:
1. Inlet and outlet of each hydronic zone.
 2. Inlet and outlet of each ground source heat pump.
 3. Inlet and outlet of each heat-recovery unit.
 4. Outside-air, return-air, and mixed-air ducts.
- B. Provide the following temperature ranges for thermometers:

1. Ground Source Heat Pump Water: 0 to 160 deg F, with 2-degree scale divisions.
2. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

- A. Install dry -case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
- D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- E. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- F. Install test plugs in tees in piping.

3.4 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.5 ADJUSTING

- A. Adjust faces of gages to proper angle for best visibility.

END OF SECTION 15522

1.8. Section 15580 - Hydronic Piping

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes piping, special-duty valves, and hydronic specialties for interior ground source heat pump water systems; makeup water for these systems; and drain lines.
- B. Related Sections include the following:
 - 1. Division 15 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
 - 2. Division 15 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
 - 3. Division 15 Section "Valves" for general-duty gate, globe, ball, butterfly, and check valves.
 - 4. Division 15 Section "Meters and Gages" for thermometers, flow meters, and pressure gages.
 - 5. Division 15 Section "Mechanical Identification" for labeling and identifying hydronic piping.
 - 6. Division 15 Section "HVAC Instrumentation and Controls" for temperature-control valves and sensors.

1.2 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride.
- B. PVC: Polyvinyl chloride.

1.3 SUBMITTALS

- A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear

the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.5 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, components, and partition assemblies.
- B. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Calibrated Balancing Valves:
 - a) Armstrong Pumps, Inc.
 - b) Flow Design, Inc.
 - c) Gerand Engineering Company.
 - d) Griswold Controls.
 - e) ITT Bell & Gossett; ITT Fluid Technology Corp.
 - f) Taco, Inc.
 - 2. Safety Valves:
 - a) Amtrol, Inc.
 - b) Armstrong Pumps, Inc.
 - c) Conbraco Industries, Inc.
 - d) ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
 - e) Kunkle Valve Division.
 - f) Spence Engineering Company, Inc.
 - 3. Expansion Tanks:
 - a) Amtrol, Inc.
 - b) Armstrong Pumps, Inc.
 - c) ITT Bell & Gossett; ITT Fluid Technology Corp.
 - d) Taco, Inc.
 - 4. Air Separators and Air Purgers:
 - a) Amtrol, Inc.
 - b) Armstrong Pumps, Inc.
 - c) ITT Bell & Gossett; ITT Fluid Technology Corp.
 - d) Taco, Inc.

2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- E. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 VALVES

- A. Gate, globe, check, and ball valves are specified in Division 15 Section "Valves."
- B. Refer to Part 3 "Valve Applications" Article for applications of each valve.
- C. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- D. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

2.5 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.
- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.
- C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Separate air charge from system

water to maintain design expansion capacity by a flexible diaphragm or bladder securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

- D. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300 deg F.
- E. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250 deg F.
- F. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

PART 3 – EXECUTION

3.1 PIPING APPLICATIONS

- A. Ground source heat pump Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints. Belowground or within slabs, use Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.
- B. Drain Lines: Type L drawn-temper copper tubing with soldered joints.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Gate and ball valves.
 - 2. Throttling Duty: Globe and ball, valves.
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

3.3 PIPING INSTALLATIONS

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
- C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for joint construction requirements for soldered and brazed joints in copper tubing.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.

C. Install in-line air separators in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install drain valve on units NPS 2 and larger.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be same as for equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure and temperature gages at coil inlet connections.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and

- compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
 3. Check expansion tanks to determine that they are not air bound and that system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.

3.9 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments before operating the system:
 1. Open valves to fully open position. Close coil bypass valves.
 2. Check pump for proper direction of rotation.
 3. Set automatic fill valves for required system pressure.
 4. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Check and set operating temperatures of heat pumps to design requirements.
 6. Lubricate motors and bearings.

3.10 CLEANING

- A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 15580

1.9. Section 15745 - Water-Source Heat Pumps

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following types of water-source heat pumps:
 - 1. Exposed, floor-mounted console units.
- B. Related Sections include the following:
 - 1. Division 15 Section "Control Systems Equipment" for control valves and specialties not integral to water-source heat pumps.
 - 2. Division 15 Section "Sequence of Operation" for control sequences.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities for each model; shipping, installed, and operating weights; furnished specialties; and accessories for each type of product specified.
- B. Shop Drawings: From manufacturer, detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Maintenance Data: For water-source heat pumps to include in the maintenance manuals specified in Division 1.
- D. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain water-source heat pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water-source heat pumps and are based on the specific system indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- C. Listing and Labeling: Provide electrically operated equipment specified in this Section that is listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- D. Test and rate water-source heat pumps according to ARI 320, "Water-Source Heat Pumps." Provide ARI certification.
- E. Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- F. Comply with the minimum COP/efficiency levels according to ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Buildings."
- G. Comply with NFPA 70.
- H. Comply with safety requirements of UL 559, "Heat Pumps," for duct-system connections.

1.4 COORDINATION

- A. Coordinate layout and installation of water-source heat pumps and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition assemblies.

1.5 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty, executed by the manufacturer, agreeing to repair or replace components of water-source heat pumps that fail in materials or workmanship within the specified warranty period.
 1. Warranty Period: 5 years from date of Substantial Completion.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 1. One set of matched fan belts for each belt-driven fan.
 2. One set of filters for each unit.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide water-source heat pumps by one of the following:
 - 1. Trane Co. (The).
 - 2. Carrier Corp.
 - 3. Climate Master, Inc.
 - 4. McQuay International.

2.2 EXPOSED, FLOOR-MOUNTED, WATER-SOURCE HEAT PUMPS

- A. Description: Factory-assembled and -tested, packaged water-source heat pumps consisting of cabinet; sealed refrigerant circuit including compressor, refrigerant-to-water heat exchanger, refrigerant-to-air heat exchanger, and reversing valve; evaporator fans; refrigeration and temperature controls; filters; dampers; and isolation valves to allow servicing of components in refrigeration circuit.
- B. Cabinet and Chassis: Manufacturer's standard galvanized-steel casing with the following features:
 - 1. Access panel for access and maintenance of internal components.
 - 2. Cabinet Insulation: Glass fiber insulation, 1/2 inch thick, 1.5-lb/cu. ft. density.
 - 3. Knockouts for electrical and piping connections.
 - 4. Condensate drain connection.
- C. Evaporator Fans: Direct-driven, centrifugal fan with permanently lubricated motor.
- D. Refrigerant-to-Water Heat Exchanger: Coaxial heat exchanger with inner copper water tube and outer steel refrigerant tube or coil-in-shell with enhanced copper tubing inside a steel shell.
- E. Refrigerant-to-Air Heat Exchanger: Copper-tube coil with aluminum fins.
- F. Reversing Valve: Manufacturer's standard control valve designed to be fail-safe in heating position.
- G. Compressor: Scroll compressor installed on vibration isolators and enclosed in acoustically treated enclosure with built-in safeties as follows:
 - 1. High-temperature cutout.
 - 2. Low-temperature cutout.
 - 3. Compressor motor overload protection.

- H. Refrigerant Piping Materials: Drawn-temper, Type ACR copper tube with wrought-copper fittings and brazed joints. Insulate refrigerant piping with 3/8-inch-thick, flexible elastomeric insulation.
 - 1. Insulation Fire-Performance Rating: 25 flame-spread and 50 smoke-developed rating according to ASTM E 84.
- I. Unit Controls: Field-installed, programmable, manual-changeover thermostat, with cool/off/heat system switch, auto/on fan switch, and 7-day programming.
 - 1. ASHRAE BACnet(TM) Compatibility: Controls compatible with ASHRAE BACnet(TM) protocol.
 - 2. Relays: Provide each unit with 2 factory-mounted and -wired relays to facilitate interface with energy management and control systems.
- J. Filters: Glass-fiber throwaway type, 1/2 inch thick, located in return-air stream.
- K. Hose Kit: 36 inches long by 1-inch- diameter hose with automatic self-balancing valve and strainer.
- L. Flow Control Center: Packaged unit including Grundfos Series UP26 pumps with stainless steel impeller and epoxy coated cast iron or bronze pump volute; valving including 1 inch FPT 3 way valves used for flushing and maintenance, insulated cabinet, and electrical terminal connections.

2.3 MOTORS

- A. Comply with requirements in Division 15 Section "Motors."

2.4 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested units before shipping.

2.5 SOURCE QUALITY CONTROL

- A. Factory test and rate heat exchangers for 400-psig refrigerant working pressure, minimum.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances, other specific conditions, and other conditions affecting performance

of water-source heat pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

- B. Examine piping and electric rough installations for water-source heat pumps to verify actual locations of piping connections before installation.

3.2 INSTALLATION

- A. Install water-source heat pumps according to manufacturer's written instructions.
- B. Install units level and plumb, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- C. Install flow control center mounted on the wall.

3.3 CONNECTIONS

- A. Piping Connections: Drawings indicate the general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Connect supply and return piping to heat pump with unions and shutoff valves.
 - 2. Connect heat-pump drain pan to nearest indirect waste connection, or as indicated.
- B. Duct Connections: Connect supply and return ducts to heat pumps with flexible duct connections. Provide transitions to match unit duct-connection size.
- C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
- D. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 CLEANING

- A. Replace filters used during construction.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of water-source heat pumps, including piping and electrical connections. Report results in writing.
 - 1. Test and adjust controls and safeties.

2. Replace damaged and malfunctioning controls and equipment.

3.6 COMMISSIONING

- A. Startup Services: Engage a factory-authorized service representative to perform startup services.
- B. Operate fan motors and verify proper rotation and connections.
- C. Operate controls and verify proper response to control inputs.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 2. Review data in the maintenance manuals specified in Division 1.
 3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 15745

1.10. Section 15762 - Electric Radiators

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Baseboard radiators.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For electric radiators to include in maintenance manuals.
- C. Warranties: Special warranties specified in this Section.

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.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric radiators that fail in materials or workmanship within specified warranty period.

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 BASEBOARD RADIATORS

- A. Available Manufacturers:
 - 1. Chromalox; Division of Emerson Electric Company.

2. Marley Electric Heating; a United Dominion Company.
 3. Q Mark
 4. Markel
- B. Heating Elements: Nickel-chromium heating wire element enclosed in metallic sheath mechanically expanded into fins, with high-temperature cutout. Element supports eliminate thermal expansion noise.
- C. Enclosures: One piece, minimum 0.030-inch- thick steel, with full-height back, full-length damper, end panel, end caps, corners, and joiner pieces to snap together. Front panel shall be easily removable.
1. Enclosure Height: 7 inches.
 2. Finish: Factory-applied baked enamel in color selected by Architect from manufacturer's standard colors.
 3. Element Brackets: Galvanized steel to support front panel and element glide.
- D. Unit Controls: Integral electronic thermostat.
- E. Accessories:
1. Blank sections.
 2. Convenience receptacles complying with NEMA WD 6, Configuration 5-15R.
- F. Capacity: As scheduled on plans.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for electric radiators to verify actual locations of electrical connections before equipment installation.
- B. Examine walls for suitable conditions where electric radiators will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install electric baseboard radiators level and plumb and according to the following, unless otherwise indicated:
 1. Center units' enclosure under windows.
 2. Join sections with manufacturer's splicer, plates, and filler pieces to provide continuous cabinet.
 3. Install manufacturer's access fitting in cabinets for access to electrical connections, controls, and other fittings.

4. Terminate enclosures with manufacturer's end caps.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing and prepare test reports:
 1. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 15762

1.11. Section 15766 - Cabinet Unit Heaters

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes cabinet unit heaters.

1.2 SUBMITTALS

- A. Product Data: Include specialties and accessories for each unit type and configuration.
- B. Maintenance Data: For cabinet unit heaters to include in maintenance manuals specified in Division 1. Include the following:
 - 1. Maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

1.3 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.

1.4 COORDINATION

- A. Coordinate layout and installation of cabinet unit heaters and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Q Mark.
 - 2. Markel.
 - 3. Dunham-Bush, Inc.
 - 4. Engineered Air.
 - 5. International Environmental Corp.
 - 6. Rosemex Products.

2.2 CABINET UNIT HEATERS

- A. Description: An assembly including chassis, coil, fan, and motor in blow-through configuration with heating coil.
- B. Cabinet: For one or more of the following configurations:
 - 1. Surface, wall mounting.
 - a) Air Inlet: Front grille .
 - b) Air Outlet: Front grille.
 - 2. Semirecessed, wall-mounting front grilles for air inlet and outlet.
 - 3. Recessed, wall-mounting front grilles for air inlet and outlet.
- C. Airflow: Up flow.

2.3 MATERIALS

- A. Chassis: Galvanized steel, with flanged edges.
- B. Cabinet: Galvanized steel, with removable panels fastened with tamperproof fasteners and key-operated access door.

2.4 ELECTRIC-RESISTANCE HEATING ELEMENTS

- A. Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium-oxide insulating refractory and sealed in high-mass steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
 - 1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for overtemperature protection of heaters.
 - 2. Wiring Terminations: Match conductor materials and sizes indicated.

2.5 FAN

- A. Centrifugal, with forward-curved, double-width wheels and fan scrolls made of galvanized steel or thermoplastic material; directly connected to motor.

2.6 FAN MOTORS

- A. Comply with requirements in Section 15 "Motors."
- B. Multispeed motor with integral thermal-overload protection and resilient mounts. Connect motor to chassis wiring with plug connection.

2.7 ACCESSORIES

- A. Steel recessing flanges for recessing cabinet unit heaters into ceiling or wall.

2.8 CONTROLS

- A. Control Devices: Unit-mounted fan-speed switch and thermostat.

2.9 SOURCE QUALITY CONTROL

- A. Test cabinet unit heater coils according to ASHRAE 33.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before cabinet unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cabinet unit heaters level and plumb.
- B. Install cabinet unit heaters to comply with NFPA 90A.

3.3 CONNECTIONS

- A. Ground equipment.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing and report results in writing:
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safeties.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

- A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. After installing units, clean cabinet unit heaters internally according to manufacturer's written instructions.
- C. Install new filters in each cabinet unit heater within two weeks after Substantial Completion.

END OF SECTION 15766

1.12. Section 15767 - Propeller Unit Heaters

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes propeller unit heaters.

1.2 SUBMITTALS

- A. Product Data: Include specialties and accessories for each unit type and configuration.
- B. Maintenance Data: For propeller unit heaters to include in maintenance manuals specified in Division 1. Include the following:
 - 1. Maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

1.3 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.

1.4 COORDINATION

- A. Coordinate layout and installation of propeller unit heaters and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Qmark Heating Products
 - 2. Marley Heating
 - 3. INDEECO
 - 4. Trane Co.

2.2 UNIT HEATERS

- A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with horizontal, adjustable louvers in blow-through configuration.

2.3 MATERIALS

- A. Casing: Galvanized steel, with removable panels.
- B. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on primer and manufacturer's standard paint applied to factory-assembled and -tested propeller unit heater before shipping.

2.4 ELECTRIC-RESISTANCE HEATING ELEMENTS

- A. Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium-oxide insulating refractory and sealed in high-mass steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
 - 1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for overtemperature protection of heaters.
 - 2. Wiring Terminations: Match conductor materials and sizes indicated.

2.5 FAN

- A. Propeller with aluminum blades directly connected to motor.

2.6 FAN MOTORS

- A. Comply with requirements in Division 15 Section "Motors."
- B. Multispeed motor with integral thermal-overload protection.

2.7 ACCESSORIES

- A. Horizontal Configuration: Louver fin diffuser.

2.8 CONTROLS

- A. Control Devices: Unit-mounted thermostat.

2.9 SOURCE QUALITY CONTROL

- A. Test propeller unit heater coils according to ASHRAE 33.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before propeller unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install propeller unit heaters level and plumb.
- B. Install propeller unit heaters to comply with NFPA 90A.

3.3 CONNECTIONS

- A. Ground equipment.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing and report results in writing:
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safeties.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

- A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

- B. After installing units, clean propeller unit heaters internally according to manufacturer's written instructions.

END OF SECTION 15767

1.13. Section 15785 - Air-To-Air Energy Recovery Units

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Fixed-plate heat exchangers.
- B. Related Sections include the following:
 - 1. Division 15 Section "HVAC Instrumentation and Controls" for control wiring and control devices connected to energy recovery units.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain air-to-air energy recovery units through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-to-air energy recovery units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASHRAE Compliance: Capacity ratings for energy recovery devices shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of equipment supports. These items are specified in Division 7 Section "Roof Accessories."

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: Furnish two set[s] of each type of filter specified.
 - 2. Fan Belts: Furnish two sets of belts for each belt-driven fan in energy recovery units.

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 PACKAGED ENERGY RECOVERY UNITS

- A. Manufacturers:
 - 1. Advanced Thermal Technologies.
 - 2. American Energy Exchange.
 - 3. Renew Aire.
 - 4. Gouvernaire.
 - 5. SEMCO Incorporated.
 - 6. Venmar Ventilation Inc.
- B. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed and calked weathertight, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.
- C. Sensible and Latent Device: Fixed-plate heat exchanger.
- D. Supply and Exhaust Fans: Forward-curved centrifugal fan with spring isolators and flexible duct connections.
 - 1. Motor and Drive: Direct driven.
 - 2. Comply with requirements in Division 15 Section "Motors."
- E. Filters: 2-inch- thick disposable type, in galvanized steel frame, mounted upstream of unit in both supply and exhaust airstreams.

- F. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.
 - 1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Division 15 Section "Duct Accessories."
- B. Support suspended units from structure; use threaded steel rods.
- C. Install units with clearances for service and maintenance.
- D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.2 CONNECTIONS

- A. Duct and fan installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts, fittings, and specialties.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Adjust seals and purge.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 4. Set initial temperature and humidity set points.
 - 5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 15785

1.14. Section 15790 - Vertical Ground-Source Heat Exchanger Systems

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes piping and specialties for vertical ground-source heat exchange systems (VGSHEs).
- B. Related Sections include the following:
 - 1. Division 15 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
 - 2. Division 15 Section "Valves" for general-duty gate, globe, ball, butterfly, and check valves.

1.2 FIELD MEASUREMENTS

- A. After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field and shall advise the Engineer of Record of any discrepancy before performing the work.

1.3 SUBMITTALS

- A. Product Data for the following:
 - 1. VGSHEs piping components.
 - 2. Manufacturer's catalog data included with the VGSHEs Installation Drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:
 - a) VGSHEs piping components, including recommendations for preparing joints using an electrofusion process.
 - 3. Propylene glycol to be supplied in the VGSHEs. The concentration, the conductivity of the propylene glycol (at all concentration levels ranging from zero to 100 percent in ten percent intervals) and other characteristics of the propylene glycol/water mixture at the concentration proposed. This data shall be supplied for each of the two extreme return temperatures of the water/propylene glycol mixture from the heat pump(s), i.e. the maximum mixture design temperature during the cooling season and the minimum design temperature during the heating season.
- B. Shop Drawings
 - 1. The Contractor shall submit drawings including VGSHEs layout, assembly and installation details, and electrical connection diagrams;

distribution manifolds and all piping, including points of connection to piping specified in other Sections. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function within the HVAC system and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance and the test point locations where the VGSHERS will be monitored during testing.

C. Test Reports

1. VGSHERS Tests: Test reports, signed by the VGSHERS Specialist, for the hydrostatic tests in booklet form, no later than 14 days after completion of testing. Reports shall document all phases of tests performed including initial test summary, all corrections and adjustments made, and final test results.

D. Certificates:

1. VGSHERS Specialist: A letter providing the name and Statement of Qualifications of the individual who will serve as the VGSHERS Specialist.
2. VGSHERS Piping Installation: Concurrent with submittal of the VGSHERS Test Reports, submit certification by the VGSHERS Specialist that the VGSHERS is installed in accordance with the contract requirements, including signed approval of the VGSHERS Test Reports.

- E. Maintenance Data: For VGSHERS specialties and accessories to include in maintenance manuals specified in Division 1.

1.4 VGSHERS SPECIALIST

- A. Work specified in this section shall be performed under the supervision of and certified by the VGSHERS Specialist. The VGSHERS Specialist shall be a Certified as an "Installer" by the International Ground Source Heat Pump Association (IGSHPA) and shall be engaged in the installation of the type and capacity of the system(s) specified in this project for the immediate three years prior to the submittal of the VGSHERS Specialist's Statement of Qualifications. The VGSHERS Specialist's Statement of Qualifications shall include a copy of IGSHPA Installer Certification and data identifying the location, VGSHERS type, and capacity of at least three systems installed under the guidance of the proposed VGSHERS Specialist during that period. The Contractor shall furnish documentation from the owner of these three VGSHERS verifying that each system has performed in the manner intended for the 6 months prior to submission of the Statement of Qualifications.

PART 2 - PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

- A. Standard Products: Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.2 VGSHES PIPING COMPONENTS

- A. VGSHES piping terminates at the point shown on the drawings.
- B. Pipe: Piping and heat-fused materials shall be manufactured from virgin polyethylene and an extrusion compound material conforming to ASTM D 2513 with PE345434C or PE355434 cell classification with an ASTM D 3350 Class C, D, or E UV stabilizer, with the exception that the material shall exhibit zero failures (FO) when tested for 192 hours or more in accordance with ASTM D 1693, condition C as required in ASTM D 3350. Pipe shall be manufactured as specified in ASTM D 2447 Schedule 40 or ASTM D 3035 with a standard dimension ratio (SDR) of 11 for pipe diameters ranging from 0.5 inches and less to 3 inches, and a minimum SDR of 17.0 for pipe diameters 3 inches and greater.
- C. Fittings: Butt and sidewall fittings shall be polyethylene and conform to ASTM D 3261. Socket fittings shall conform to ASTM D 2513; electrofusion fittings shall conform to ASTM F 1055. Barbed fittings and hose clamps shall not be used.

2.3 GROUTING MATERIAL

- A. The annular space between the vertical bore wall and the u-bend assembly shall be filled with a bentonite-based grouting material with a minimum solids content of 20% as specified by grout manufacturer. The grouting material shall be mixed in strict accordance to the manufacturers mixing instructions. Grouting material shall be placed using a pressure pump with a tremie pipe system. The material shall be installed from the bottom to the top of the vertical bore. If any settling occurs during the initial 24-hour period after installation, additional material shall be added to insure that grouting material remains at surface level.
- B. In the event that a geological formation is encountered that prevents the grouting material from forming a solid seal, either a 3/8 inch (9.5 mm) or 3/4 inch (19 mm) granular bentonite material may be used through that specific formation zone. Upon completion of that specific zone, the grout slurry shall continue to be used until reaching the surface of the vertical bore.
- C. Grout manufacturer and percent solids shall be reported immediately following bore completion.

2.4 CONTROLS

- A. Controls for the VGSHEs shall be integrated with the HVAC system controls package specified in Section 15900. VGSHEs controls shall be designed in accordance with the manufacturer's recommendations and to comply with the sequence of controls shown on the drawings.

PART 3 - EXECUTION

3.1 VGSHEs PIPING INSTALLATION

- A. Piping components shall be joined by a heat fusion method that conforms the piping manufacturer's recommendation for this application. Threaded connections are not allowed.

3.2 EARTHWORK

- A. Earthwork shall be performed in accordance with applicable provisions of Division 2 EARTHWORK, except that thermally enhanced grouts shall be used where indicated on the approved VGSHEs Installation Drawings.
- B. Vertical bore drilling: Vertical bore can be drilled either by a mud-rotary drilling rig or by a compressed-air drilling rig which ever is most feasible based on geological conditions.
- C. Drilling permits & regulations: Drilling contractor shall be responsible for all permits and following all applicable codes and regulations. Where any discrepancy exists between local codes and regulations and this specification, the more stringent of the two documents prevail.
- D. Site protection: Drilling contractor shall take all necessary precautions to protect the site from any damage resulting from the drilling operation.
- E. Bore Diameter: The diameter of the vertical bore shall not be greater than 6 inches and shall not be less than 3.5 inches. The final diameter shall be determined by the drilling contractor's available equipment.
- F. Completed Bore Depth: The completed bore depth shall be within 5% of the final estimated design bore depth for the specific project. The completed depth shall be determined by the placement of the u-bend. The distance from the bottom of the u-bend to the surface shall constitute the completed bore depth. At minimum, an additional 5 feet (1.5 m) of pipe length (on both the supply and return legs) shall be left above the installed u-bend assembly, above ground level/finished grade.

3.3 FIELD PAINTING AND FINISHING

- A. Field painting and finishing are specified in Division 9 PAINTS AND COATINGS.

3.4 TESTING, ADJUSTING, AND BALANCING

- A. Testing, adjusting, and balancing shall be by the mechanical contractor and shall be as specified in Section 15950 TESTING, ADJUSTING, AND BALANCING. Testing, adjusting, and balancing shall begin only when the entire HVAC system, including controls, has been completed with the exception of performance tests. The VGSHEs shall be charged with premixed propylene glycol solution (type and concentration as specified by the VGSHEs Designer) prior to testing, adjusting, and balancing.

3.5 VGSHEs TESTS

- A. Hydrostatic Test: Prior to any cover or backfill of bore holes or trenches, the VGSHEs piping shall be isolated from all connections to piping within the building and shall be flushed of all dirt and debris using potable water flowing at twice the normal operating VGSHEs flow rate for a minimum of four hours or until no dirt or debris is visible, whichever is greater. The VGSHEs piping shall then be plugged or capped as necessary in preparation for the hydrostatic test(s). The piping shall be pressurized to 150 psi and monitored for a period of 8 hours. If there is any pressure loss or visible leakage during this period, the leak shall be identified and repaired in accordance with the piping components manufacturer's recommendations. Test shall be repeated until there is no loss in pressure during the test period.
- B. System Diagrams: The Contractor shall submit System diagrams that show the layout of equipment, piping, and circulation pumps, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

3.6 ON-SITE TRAINING

- A. The VGSHEs Designer shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 4 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The on-site training shall cover all of the items contained in the approved Operating and Maintenance Instructions.

END OF SECTION 15790

1.15. Section 15815 - Metal Ducts

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall, round spiral-seam ducts and formed fittings.
- B. Related Sections include the following:
 - 1. Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.3 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.
- B. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 – PRODUCTS

2.1 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 thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 or G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.
- C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 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 concretes or for slabs more than 4 inches thick.
 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
 3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.5 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
1. Manufacturers:
 - a) Ductmate Industries, Inc.
 - b) Nexus Inc.
 - c) Ward Industries, Inc.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Manufacturers:
 - a) Ductmate Industries, Inc.
 - b) Lockformer.
 2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
 3. Longitudinal Seams: Pittsburgh lock sealed with non-curing polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of non-braced panel area unless ducts are lined.

2.6 ROUND DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Round, Spiral Lock -Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- C. Duct Joints:
 1. Ducts up to 48 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
- D. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- E. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- F. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Unless elbow construction type is indicated, fabricate elbows as follows:
 1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
 2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
 - a) Ducts 3 to 36 Inches in Diameter: 0.034 inch.
 3. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.

4. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
5. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
6. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
7. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
8. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
9. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

PART 3 – EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 1. Supply Ducts: 1-inch wg .
 2. Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg .
 3. Return Ducts (Negative Pressure): 1-inch wg.
 4. Exhaust Ducts (Negative Pressure): 1-inch wg .
- B. All ducts shall be galvanized steel.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections.

- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories."
- O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes.
- P. Protect duct interiors from the elements and foreign materials until building is enclosed.
- Q. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

3.3 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
 - 1. For pressure classes lower than 2-inch wg, seal transverse joints.
- B. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular

ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.

4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 15815

1.16. Section 15820 - Duct Accessories

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Motorized control dampers.
 - 4. Turning vanes.
 - 5. Duct-mounting access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.
 - 8. Duct accessory hardware.
- B. Related Sections include the following:
 - 1. Division 15 Section "HVAC Instrumentation and Controls" for electric and pneumatic damper actuators.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Motorized control dampers.
 - 4. Turning vanes.
 - 5. Duct-mounting access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.4 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

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 thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 or G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. CESCO Products.
 - 3. Duro Dyne Corp.
 - 4. Greenheck.
 - 5. Penn Ventilation Company, Inc.
 - 6. Prefco Products, Inc.
 - 7. Ruskin Company.
 - 8. Vent Products Company, Inc.
- B. Description: Multiple-blade, parallel action gravity balanced, with blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- C. Frame: 0.063-inch- thick extruded aluminum, with welded corners.
- D. Blades: 0.050-inch- thick aluminum sheet.

- E. Blade Seals: Neoprene.
- F. Blade Axles: Nonferrous.
- G. Tie Bars and Brackets: Aluminum or Galvanized steel.
- H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating.
 - 3. Flexmaster U.S.A., Inc.
 - 4. McGill AirFlow Corporation.
 - 5. METALAIRE, Inc.
 - 6. Nailor Industries Inc.
 - 7. Penn Ventilation Company, Inc.
 - 8. Ruskin Company.
 - 9. Vent Products Company, Inc.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
 - 1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 - 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
 - 3. Blade Axles: Galvanized steel or Stainless steel
 - 4. Bearings: Oil-impregnated bronze or Molded synthetic.
 - 5. Tie Bars and Brackets: Aluminum.
 - 6. Tie Bars and Brackets: Galvanized steel.
- D. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- E. Damper Hardware: 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. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 MOTORIZED CONTROL DAMPERS

- A. Manufacturers:
1. Greenheck.
 2. METALAIRE, Inc.
 3. Penn Ventilation Company, Inc.
 4. Ruskin Company.
 5. Vent Products Company, Inc.
- B. General Description: AMCA-rated, opposed-blade design; minimum of 0.1084-inch- thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch- thick, galvanized-steel damper blades with maximum blade width of 8 inches.
1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 2. Operating Temperature Range: From minus 40 to plus 200 deg F.
 3. Provide closed-cell neoprene edging.

2.6 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single -vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
1. Manufacturers:
 - a) Ductmate Industries, Inc.
 - b) Duro Dyne Corp.
 - c) METALAIRE, Inc.
 - d) Ward Industries, Inc.

2.7 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.

- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
 - 1. Manufacturers:
 - a) American Warming and Ventilating.
 - b) CESCO Products.
 - c) Ductmate Industries, Inc.
 - d) Flexmaster U.S.A., Inc.
 - e) Greenheck.
 - f) McGill AirFlow Corporation.
 - g) Nailor Industries Inc.
 - h) Ventfabrics, Inc.
 - i) Ward Industries, Inc.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Provide number of hinges and locks as follows:
 - a) Less Than 12 Inches Square: Secure with two sash locks.
 - b) Up to 18 Inches Square: Two hinges and two sash locks.
- C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
 - 1. Manufacturers:
 - a) Ductmate Industries, Inc.
 - b) Flexmaster U.S.A., Inc.
 - 2. Frame: Galvanized sheet steel, with spin-in notched frame.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- E. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.8 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Corp.
 - 3. Ventfabrics, Inc.
 - 4. Ward Industries, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.9 FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Flexmaster U.S.A., Inc.
 - 2. Hart & Cooley, Inc.
 - 3. McGill AirFlow Corporation.
- B. Noninsulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
- C. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
- D. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.10 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 – EXECUTION

3.1 APPLICATION AND 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. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- E. Provide balancing dampers for all diffuser and equipment connections unless noted otherwise.
- F. Provide additional balancing dampers that are required to achieve a balanced system but not shown on the drawings. Install balancing dampers a minimum of two duct widths from branch takeoff.
- G. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. Downstream from volume dampers, turning vanes, and equipment.
 - 2. Adjacent to fire dampers, providing access to reset or reinstall fusible links.
 - 3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
 - 4. On sides of ducts where adequate clearance is available.
- I. Install the following sizes for duct-mounting, rectangular access doors:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
- J. Install the following sizes for duct-mounting, round access doors:
 - 1. One-Hand or Inspection Access: 8 inches in diameter.
 - 2. Two-Hand Access: 10 inches in diameter.
 - 3. Head and Hand Access: 12 inches in diameter.

- K. Label access doors according to Division 15 Section "Mechanical Identification."
- L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- M. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- N. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.
- O. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION

1.17. Section 15855 - Diffusers, Registers, And Grilles

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
 - 1. Division 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Division 15 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

PART 2 – PRODUCTS

2.1 GRILLES, REGISTERS AND DIFFUSERS

- A. Grilles, registers and diffusers shall be as manufactured by Titus, Carnes, Anemostat, MetalAire, Krueger or Tuttle & Bailey.
- B. Types, sizes, patterns, deflections, finishes, and all accessories are scheduled on the drawings.
- C. All grilles registers and diffusers shall be compatible with adjacent wall and ceiling systems. Confirm ceiling type with existing conditions and architectural plans and provide appropriate frame.
- D. Provide 3 operating keys for each type of volume damper.
- E. Provide galvanized sheet metal transitions, collars, or plenums for attaching grilles to ductwork.
- F. All grilles, registers, and diffusers located in suspended lay-in ceilings shall be compatible with the following ceiling grid system:
 - 1. Standard width 15/16" ceiling tees.

PART 3 - PART 3 EXECUTION

3.1 GRILLES, REGISTERS AND DIFFUSERS

- A. Install ceiling grilles, diffusers and registers where shown on drawings.
- B. Coordinate exact location of ceiling grilles, diffusers and registers with new electrical lighting and architectural reflected ceiling plans.
- C. Confirm proper orientation of all units with unit manufacturer.

END OF SECTION 15855

1.18. Section 15900 - HVAC Instrumentation And Controls

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Division 15 Section "Sequence of Operation" for requirements that relate to this Section.

1.2 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. LAN: Local area network.
- C. MS/TP: Master-slave/token-passing.
- D. PICS: Protocol Implementation Conformance Statement.

1.3 SYSTEM DESCRIPTION

- A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. Each control device labeled with setting or adjustable range of control.
- B. Maintenance Data: For systems to include in maintenance manuals specified in Division. 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. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 4. Calibration records and list of set points.
- C. 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.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.6 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 unit manufacturer.

1.7 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

1.8 POWER

- A. Provide all electrical circuits; including circuit breaker, conduit, wire and terminations; to the nearest 120V electrical panel as required for control transformers, panels and devices unless otherwise shown on plans. Refer to Division 16000 sections for specific requirements of electrical work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Control Systems Components:
 - a) Trane Co.
 - b) BEC Controls Corp.
 - c) Belimo Aircontrols (USA), Inc.
 - d) Honeywell, Inc.; Home & Building Control.
 - e) Johnson Controls, Inc.; Controls Group.
 - f) Landis & Staefa, Inc.

2.2 ANALOG CONTROLLERS

- A. Step Controllers: Six- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.3 SENSORS

- A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
 - 1. Thermistor temperature sensors as follows:
 - a) Accuracy: Plus or minus 0.5 deg F at calibration point.
 - b) Wire: Twisted, shielded-pair cable.

2.4 THERMOSTATS

- A. Combination Thermostat and Fan Switches: Line-voltage thermostat with two-, three-, or four-position, push-button or lever-operated fan switch.
 - 1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," "FAN HIGH-MED-LOW-OFF." Provide unit for mounting on two-gang switch box.
- B. Electric solid-state, microcomputer-based room thermostat with remote sensor.
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from set point.
 - 3. Set up for four separate temperatures per day.
 - 4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
 - 5. Short-cycle protection.
 - 6. Programming based on every day of week.
 - 7. Selection features include deg F or deg C display, 12- or 24-hour clock, keyboard disable, remote sensor, fan on-auto.
 - 8. Battery replacement without program loss.
 - 9. Thermostat display features include the following:
 - a) Time of day.
 - b) Actual room temperature.
 - c) Programmed temperature.
 - d) Programmed time.
 - e) Duration of timed override.
 - f) Day of week.
 - g) System mode indications include "heating," "off," "fan auto," and "fan on."
- C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.
- D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.
 - 1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
 - 2. Dead Band: Maximum 2 deg F.
- E. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
 - 1. Set-Point Adjustment: Concealed.
 - 2. Set-Point Indication: Exposed.
 - 3. Thermometer: Concealed.
- F. Room thermostat accessories include the following:
 - 1. Insulating Bases: For thermostats located on exterior walls.

2. Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

2.5 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 1. Comply with requirements in Division 15 Section "Motors."
 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
- B. Electronic Damper Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 1. Valves: Size for torque required for valve close-off at maximum pump differential pressure.
 2. Dampers: Size for running torque calculated as follows:
 - a) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
 - b) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
 3. Coupling: V-bolt and V-shaped, toothed cradle.
 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 6. Power Requirements (Two-Position Spring Return): 24 -V ac.
 7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 9. Temperature Rating: Minus 22 to plus 122 deg F.
 10. Run Time: 12 seconds open, 5 seconds closed.

2.6 DAMPERS

- A. Dampers: AMCA-rated, opposed-blade design; 0.1084-inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635-inch galvanized steel with maximum blade width of 8 inches.
 1. Blades shall be secured to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. For standard applications, include optional closed-cell neoprene edging.
4. For low-leakage applications, use parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.7 CONTROL CABLE

- A. Electronic and Fiber-Optic Cable for Control Wiring: As specified in Division 16 Section "Control/Signal Transmission Media."

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices and wiring and pneumatic piping are installed before proceeding with installation.

3.2 INSTALLATION

- A. Install equipment level and plumb.
- B. Connect and configure equipment to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate all 60 inches above the floor.
 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats in the following locations:
 1. Entrances.
 2. Public areas.
 3. Where indicated.
- E. Install automatic dampers according to Division 15 Section "Duct Accessories."
- 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 15 Section "Basic Mechanical Materials and Methods."

- H. Install labels and nameplates to identify control components according to Division 15 Section "Mechanical Identification."
- I. Install hydronic instrument wells, valves, and other accessories according to Division 15 Section "Hydronic Piping."
- J. Install duct volume-control dampers according to Division 15 Sections specifying air ducts.
- K. Install electronic and fiber-optic cables according to Division 16 Section "Communications Cable and Equipment".

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 16 Section "Raceways and Boxes."
- B. Install building wire and cable according to Division 16 Section "Conductors and Cables."
- C. Install signal and communication cable according to Division 16 Section "Communications Cable and Equipment".
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to machine to allow service and maintenance.
- B. Ground equipment.
 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
- B. Replace damaged or malfunctioning controls and equipment.
 1. Start, test, and adjust control systems.
 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.6 DEMONSTRATION

- A. Engage a factory-authorized 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 "Contract Closeout."
 4. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 5. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 15900

1.19. Section 15940 - Sequence Of Operations

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. Related Sections include the following:
 - 1. Division 15 Section "HVAC Instrumentation and Controls" for control equipment and devices and submittal requirements.

1.2 HEAT PUMPS

- A. Programmable thermostat to stage heating or cooling sequence of the compressors based on demand. Supply Fan shall run continuously during Occupied Mode and should cycle per heat/cooling demand in the unoccupied mode.

1.3 HEAT PUMPS FLOW CENTER

- A. Interlock flow center pumps with heat pumps to run Circulation pumps based on heating/cooling demand. Coordinate interlock with manufacturer. Sequence and wiring should be packaged. Provide any field wiring or devices as required.

1.4 HEAT RECOVERY UNIT

- A. Interlock heat recovery unit with both heat pumps. If either of heat pump units is in Occupied Mode, run heat recovery unit. Close Outside Air and Exhaust Air Dampers when unit is "off".

1.5 ALARM

- A. Provide remote alarm indicated if either of the heat pumps is in "Failure" Mode.

1.6 TERMINAL UNIT OPERATING SEQUENCE

- A. Cabinet Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
- B. Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
- C. Radiators and Convectors, Electric: Room thermostat cycles coils.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 15940

1.20. Section 15950 - Testing, Adjusting, And Balancing

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a) Constant-volume air systems.
 - 2. Hydronic Piping Systems:
 - a) Constant-flow systems.
 - 3. HVAC equipment quantitative-performance settings.
 - 4. Verifying that automatic control devices are functioning properly.
 - 5. Reporting results of activities and procedures specified in this Section.

1.2 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Balancing Devices: All installed devices necessary to achieve proper balancing of the system such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers.
- D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- F. NC: Noise criteria.
- G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- H. RC: Room criteria.
- I. Report Forms: Test data sheets for recording test data in logical order.

- J. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- K. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- M. 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.
- N. TAB: Testing, adjusting, and balancing.
- O. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- P. Test: A procedure to determine quantitative performance of systems or equipment.
- Q. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 SUBMITTALS

- A. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- B. Warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. 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."
- C. 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."

- D. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 PROJECT CONDITIONS

- A. 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.

1.6 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

- A. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Verify that balancing devices are required by the Contract Documents. Verify that quantities and locations of these balancing devices are

accessible and appropriate for effective balancing and for efficient system and equipment operation.

2. The TAB Firm shall review the Contract Documents and the Mechanical Contractor's shop drawings to identify any additional balancing devices that are necessary to achieve a balanced system but not shown on the drawings. Furnish and install those additional balancing devices necessary to achieve a balanced system. Coordinate with the Mechanical Contractor to properly schedule this work. Failure to coordinate installation of these devices with the Mechanical Contractor will result in absorbing all costs associated with work of other trades that is affected by modification of building components and systems. All balancing devices and installations shall comply with other Division 15 sections.
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- B. Examine approved submittal data of HVAC systems and equipment.
 - C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."
 - D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
 - E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
 - F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
 - G. Examine system and equipment test reports.
 - H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine strainers for clean screens and proper perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine equipment for installation and for properly operating safety interlocks and controls.
- P. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to indicated values.
- Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.

- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

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 outside-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 condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling unit components.
- K. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b) Measure static pressure directly at the fan outlet or through the flexible connection.
 - c) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d) Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a) Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. 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 terminal outlets and inlets without making adjustments.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check expansion tank liquid level.
 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.

- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.9 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.

- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.10 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.
 - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
 - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.11 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB firm who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a) Indicated versus final performance.
 - b) Notable characteristics of systems.
 - c) Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a) Settings for outside-, return-, and exhaust-air dampers.
 - b) Conditions of filters.
 - c) Cooling coil, wet- and dry-bulb conditions.
 - d) Face and bypass damper settings at coils.
 - e) Fan drive settings including settings and percentage of maximum pitch diameter.
 - f) Inlet vane settings for variable-air-volume systems.
 - g) Settings for supply-air, static-pressure controller.
 - h) Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- F. Heat Pump Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
 - a) Unit identification.
 - b) Location.
 - c) Make and type.
 - d) Model number and unit size.
 - e) Manufacturer's serial number.
 - f) Unit arrangement and class.
 - g) Discharge arrangement.
 - h) Sheave make, size in inches, and bore.
 - i) Sheave dimensions, center-to-center, and amount of adjustments in inches.

- j) Number of belts, make, and size.
- k) Number of filters, type, and size.
- 2. Motor Data:
 - a) Make and frame type and size.
 - b) Horsepower and rpm.
 - c) Volts, phase, and hertz.
 - d) Full-load amperage and service factor.
 - e) Sheave make, size in inches, and bore.
 - f) Sheave dimensions, center-to-center, and amount of adjustments in inches.
- 3. Test Data (Indicated and Actual Values):
 - a) Total airflow rate in cfm.
 - b) Total system static pressure in inches wg.
 - c) Fan rpm.
 - d) Discharge static pressure in inches wg.
 - e) Filter static-pressure differential in inches wg.
 - f) Preheat coil static-pressure differential in inches wg.
 - g) Cooling coil static-pressure differential in inches wg.
 - h) Heating coil static-pressure differential in inches wg.
 - i) Outside airflow in cfm.
 - j) Return airflow in cfm.
 - k) Outside-air damper position.
 - l) Return-air damper position.
 - m) Vortex damper position.

G. Apparatus-Coil Test Reports:

- 1. Coil Data:
 - a) System identification.
 - b) Location.
 - c) Coil type.
 - d) Number of rows.
 - e) Fin spacing in fins per inch o.c.
 - f) Make and model number.
 - g) Face area in sq. ft..
 - h) Tube size in NPS.
 - i) Tube and fin materials.
 - j) Circuiting arrangement.
- 2. Test Data (Indicated and Actual Values):
 - a) Airflow rate in cfm.
 - b) Average face velocity in fpm.
 - c) Air pressure drop in inches wg.
 - d) Outside-air, wet- and dry-bulb temperatures in deg F.
 - e) Return-air, wet- and dry-bulb temperatures in deg F.
 - f) Entering-air, wet- and dry-bulb temperatures in deg F.
 - g) Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h) Water flow rate in gpm.

- i) Water pressure differential in feet of head or psig.
 - j) Entering-water temperature in deg F.
 - k) Leaving-water temperature in deg F.
 - l) Refrigerant expansion valve and refrigerant types.
 - m) Refrigerant suction pressure in psig.
 - n) Refrigerant suction temperature in deg F.
 - o) Inlet steam pressure in psig.

- 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 deg F.
 - d) Duct static pressure in inches wg.
 - e) Duct size in inches.
 - f) Duct area in sq. ft..
 - g) Indicated airflow rate in cfm.
 - h) Indicated velocity in fpm.
 - i) Actual airflow rate in cfm.
 - j) Actual average velocity in fpm.
 - k) Barometric pressure in psig.

- I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - 1. Unit Data:
 - a) Unit identification.
 - b) Location.
 - c) Service.
 - d) Make and size.
 - e) Model and serial numbers.
 - f) Water flow rate in gpm.
 - g) Water pressure differential in feet of head or psig.
 - h) Required net positive suction head in feet of head or psig.
 - i) Pump rpm.
 - j) Impeller diameter in inches.
 - k) Motor make and frame size.
 - l) Motor horsepower and rpm.
 - m) Voltage at each connection.
 - n) Amperage for each phase.
 - o) Full-load amperage and service factor.
 - p) Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a) Static head in feet of head or psig.
 - b) Pump shutoff pressure in feet of head or psig.
 - c) Actual impeller size in inches.

- d) Full-open flow rate in gpm.
 - e) Full-open pressure in feet of head or psig.
 - f) Final discharge pressure in feet of head or psig.
 - g) Final suction pressure in feet of head or psig.
 - h) Final total pressure in feet of head or psig.
 - i) Final water flow rate in gpm.
 - j) Voltage at each connection.
 - k) Amperage for each phase.
- J. Air-to-Air Heat-Recovery Unit Reports:
- 1. Unit Data:
 - a) Unit identification.
 - b) Location.
 - c) Service.
 - d) Make and type.
 - e) Model and serial numbers.
 - 2. Motor Data:
 - a) Make and frame type and size.
 - b) Horsepower and rpm.
 - c) Volts, phase, and hertz.
 - d) Full load amperage and service factor.
 - e) Sheave make, size in inches, and bore.
 - f) Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - 3. If fans are an integral part of the unit, include the following for each fan:
 - a) Make and type.
 - b) Arrangement and size.
 - c) Sheave make, size in inches, and bore.
 - d) Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - 4. Test Data (Indicated and Actual Values):
 - a) Total exhaust airflow rate in cfm.
 - b) Purge exhaust airflow rate in cfm.
 - c) Outside airflow rate in cfm.
 - d) Total exhaust fan static pressure in inches wg.
 - e) Total outside-air fan static pressure in inches wg.
 - f) Pressure drop on each side of recovery wheel in inches wg.
 - g) Exhaust air temperature entering in deg F.
 - h) Exhaust air temperature leaving in deg F.
 - i) Outside-air temperature entering in deg F.
 - j) Outside-air temperature leaving in deg F.
 - k) Calculate sensible and total heat capacity of each airstream in MBh.

3.12 INSPECTIONS

- A. Inspection:

1. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
2. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
3. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
5. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
6. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.13 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 15950

41. SWEF Building, Electrical, Item SPV.0105.14.

A Description

This item consists of the electrical work for the SWEF building. The work shall be in accordance with the applicable plans and the following specifications.

B Measurement

The department will measure SWEF Building, Electrical, completed in accordance to the contract and accepted, as a single complete unit of work.

C Payment

The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.014	SWEF Building, Electrical	LS

Payment shall be full compensation for furnishing all materials and equipment; and for supplying all labor, tools, equipment, and incidentals necessary to complete the work.

1.1. Section 16050 - Basic Electrical Materials And Methods

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. The Electrical drawings do not attempt to show complete details of building construction which affects the electrical installation. The Contractor shall refer to the complete set of project drawings and specifications for additional details, which affect the proper installation of this work.
- B. The mention of any article, operation, or method requires that the Contractor shall provide same and perform each operation, in complete accordance with the conditions stated. The Contractor shall provide all material, labor, equipment and transportation as necessary to complete the project in compliance with the Contract Documents. In general, this work includes everything essential for a complete electrical system in operating order as shown on the drawings and as specified.
- C. All work shall be installed in accordance with all State and Local Inspection Authorities having jurisdiction together with the recommendations of the manufacturer whose equipment is to be supplied and installed under this Contract. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with the present practices of the trade shall not relieve the Contractor from providing such additional labor and materials.
- D. Before submitting his bid, each bidder shall examine the drawings relating to his work and shall become fully informed as to the extent and character of the work required and its relation to other work in the building.
- E. The Contractor, in conjunction with the Construction Manager, shall establish exact locations of all materials and equipment to be installed. Consideration shall be given to construction features, equipment of other trades and requirements of the equipment proper.

- F. All materials shall be suitably stored and protected prior to installation and all work shall be protected after installation, during construction and prior to acceptance.
- G. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for delivery, erection and installation of all equipment and apparatus required to be installed by the Contractor. All such equipment shall be removed by the Contractor upon completion of the project.

1.3 PERMITS AND LICENSES

- A. The Contractor shall prepare and submit all applications and working drawings, as required, to authorities having jurisdiction over the project. All licenses and permits required shall be secured and paid for by the Contractor. The Contractor shall submit a copy of all permits secured to the Owner.
- B. Provide the Owner with a written certificate that all parts of the electrical system have been inspected and final approval has been obtained from the appropriate authority having jurisdiction.
- C. Provide a copy of the electrical permit to the Owner representative prior to proceeding with any work.

1.4 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.
- F. Provide: Furnish, install and wire complete and ready for service.
- G. Exposed: Exposed to view in any room, corridor or stairway.
- H. The Architect: Meg E. Roback, AIA, Vierbiecher Associates, Inc.
- I. The Engineer: IBC Engineering Services, Inc.
- J. Code: National, State and Local Electrical codes including OSHA requirements.
- K. The Owner: The individual who the Owner selects as his project representative.

- L. Equivalent: Manufacturers or methods listed by name in the specifications, on the drawings or in an addendum are considered to be equivalent subject to Engineer review.
- M. Substitution: Any manufacturer or method other than those listed by name in these specifications, on the drawings, or in an addendum.

1.5 SUBMITTALS

- A. Submit to Engineer for review, the manufacturer's shop drawings and/or equipment brochures in quantities determined by the Architect for the following:
 - 1. Wiring devices.
 - 2. Panelboards.
 - 3. Lighting Fixtures.
 - 4. Conduit fittings.
 - 5. Sealing and Fireproofing.
 - 6. Supporting Devices.
 - 7. Fire Alarm Equipment.
 - 8. Grounding materials.
 - 9. Lighting Control Devices
 - 10. Lightning Protection System
 - 11. Service Equipment
 - 12. Starters and Disconnect Switches.
 - 13. Nameplate Schedule.
- B. Shop drawings shall be submitted in advance of construction and installation so as to not cause delay in other Contractor's work and to allow for Engineer's review.
- C. All data submitted for Engineer's review shall be numbered consecutively, shall be noted to correlate with the electrical drawings, and shall bear:
 - 1. The name and location of the project.
 - 2. The name of the Contractor.
 - 3. The date of submittal.
 - 4. The date of the drawings and the date of each correction and revision
 - 5. If more than one type of lighting fixture (or other material) is on a submitted sheet, the proposed equipment shall be conspicuously checked with red pen by the Electrical Contractor.
 - 6. Failure to do this, may result in the submittal(s) being returned to the Contractor for correction and re-submission.
 - 7. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.
- D. The Contractor shall examine, stamp and sign shop drawings and equipment brochures prior to submission. The Contractor shall verify that the materials and equipment depicted will properly fit into the construction. The Contractor shall

also review all previously completed work related to the installation of the equipment depicted to insure that it has been properly installed.

- E. No materials or equipment subject to prior review by the Engineer shall be fabricated or installed by the Contractor. The Engineer's review of shop drawings shall not relieve the Contractor of responsibility for deviations from the requirements of the drawings and specifications, unless prior approval for such deviations has been granted.
- F. Submit additional materials at the request of the Engineer.
- G. Shop drawings shall bear the Contractor's stamp indicating approval or approved as noted.
- H. Any equipment fabrication prior to shop drawing review shall be at the Contractor's risk.
- I. Any shop drawing not meeting the requirements as outlined in this or any other part of these specifications and/or drawings, requiring more than two reviews or in excess of 4 hours of total review time shall be subject to a fee payable to the Engineer by the Contractor. This fee shall be assessed based upon a Time/Material bases at an hourly rate of \$150.00/per hour of review time. This cost shall be paid by the Contractor upon completion of review of the material, regardless of exceptions taken of the submitted equipment or design subject to Engineer's review.

1.6 MAINTENANCE MANUALS

- A. The Contractor shall assemble and submit to the Architect for subsequent submission to the Owner, three complete sets of a Manual of Operation and Maintenance for each of the electrical and communications systems.
- B. Each manual shall consist of a loose leaf bound volume instructing the Owner's personnel in the use, operation and maintenance of the system in question. The manual shall cover all phases of operation and maintenance of the equipment. Manuals shall accurately describe the operation, construction and adjustable features of the complete system and it's component parts.
- C. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
 - 1. Copies of all reviewed submittals bearing Contractor's stamp indicating approval or approved as noted.
 - 2. Manufacturer's wiring diagrams for electrically powered equipment.
 - 3. Records of tests performed to certify compliance with system requirements.

4. Certificates of inspection by regulatory agencies.
5. Parts lists for manufactured equipment.
6. Preventive maintenance recommendations.
7. Warranties.
8. Additional information as indicated in the technical specification sections.

1.7 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to Division 1, General Conditions of the Contract, and SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN.
- B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- C. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply
- D. All work and material shall conform with the National Electrical Code (ANSI/NFPA 70).
- E. All materials, except medium voltage equipment and components, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by the Architect/Engineer, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, except for medium voltage equipment and components, shall be so labeled.

1.8 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

- C. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.
- D. Coordinate all work with other contractors/subcontractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.
- E. 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.
 - 3. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
 - 4. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Coordination Meetings: Attend coordination meetings with the construction manager and all other trades for the purpose of coordinating the locations of all fire protection, plumbing, HVAC and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field.
- G. Coordination Drawings: Each fire protection, plumbing, HVAC and electrical contractor shall develop ¼" coordination floor plan drawings for all of their respective working areas that necessitate additional coordination to allow for efficient systems installation. Each coordination drawing, for all trades, shall be signed and dated by each trade indicating that each trade has fully coordinated their work
- H. Conflicts Between Trades: Resolve all conflicts with trades at no additional cost to the Owner or Architect/Engineer.
- I. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of fire protection, HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.

- J. Ceiling Grid Priority: Lighting fixture locations take priority over diffuser and sprinkler head locations.

1.9 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. These specifications and attendant drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with present practices of the trade shall not relieve the Contractor from providing such additional labor and materials. No later than ten (10) days before bid opening, the Contractor shall call the attention of the Architect/Engineer in writing to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points in writing with the Architect/Engineer before submitting his bid. In lieu of written clarification by addendum, resolve all conflicts in favor of the greater quantity or better quality.
- B. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
- C. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits the Architect/Engineer's intent (as determined by the Engineer). Refer to the General Conditions of the Contract for further clarification.
- D. It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site with the Owner's representative and be responsible for their accuracy. Where appropriate the location shall be established in accordance with the manufacturer's installation drawings and details subject to the Architect's review.
- E. All sizes as given are minimum except as noted.
- F. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Authority Having Jurisdiction inspections and A/E's reviews, tests and approval from the commencement until the acceptance of the completed work.
- G. Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply. Refer to Division 1, General Conditions of the Contract.

- H. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring electrical connections to verify rough-in and connection locations.
- I. Unless specifically stated to the contrary, no measurement of an electric drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the electric drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

1.10 DRAWINGS

- A. The Electrical drawings do not attempt to show the complete details of building construction which affect the electrical installation. The Contractor shall refer to the architectural, civil, structural and mechanical drawings for additional details which affect the proper installation of this work. Bring any discrepancies to the attention of the A/E for resolution. The Contractor is cautioned that diagrams showing electrical connections and/or circuiting are diagrammatic only and must not be used for obtaining lineal runs of wire to conduit. Wiring diagrams do not necessarily show the exact physical arrangement of the equipment.
- B. The Engineer will make available to the Contractor a set of electronic AutoCad files to the Contractor. Each electronic copy requested will be put on disk for the cost \$200 to cover technician time and mailing costs payable by the Contractor to the Engineer. Any requests shall be made in writing to the Engineer with a certified check or money order payable to the IBC Engineering Services, Inc. The disk(s) will be sent out within 7 days of receipt of the full payment.
- C. The Contractor shall be responsible for all existing field conditions; review existing field conditions prior to bid and shall take into account in bid proposal. No additional compensation will be allowed due to Contractor's failure to include all necessary work in the bid proposal.

1.11 MATERIAL AND EQUIPMENT

- A. All material and equipment shall be new and of the quality used for the purpose in good commercial practice, and shall be standard product of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, catalog number, and capacity or rating on a nameplate, securely affixed on the equipment in a conspicuous place.

1.12 DAMAGE TO OTHER WORK

- A. The Electrical Contractor will be held rigidly responsible for all damages to the work of his own or any other trade resulting from the execution of his work. It

shall be the Contractor's responsibility to adequately protect his work at all times. All damages resulting from his operations shall be repaired or the damaged portions replaced by the party originally performing the work, (to the entire satisfaction of the Architect), and all cost thereof shall be borne by the Contractor responsible for the damage.

1.13 COOPERATION WITH OTHER TRADES

- A. This Contractor shall completely cooperate with all other trades in the matter of planning and executing of the work. Every reasonable effort shall be made to prevent conflict and interferences as to space requirements, dimensions, locations, openings, sleeving or other matters which tend to delay or obstruct the work of any trade.

1.14 NEGLIGENCE

- A. Should the Contractor fail to provide materials, templates, etc., or other necessary information causing delay or expense to another party, he shall pay the actual amount of the damages to the party who sustained the loss.

1.15 FIELD CHANGES

- A. Should any change in drawings or specifications be required to comply with local regulations and/or field conditions, the Contractor shall refer same to Architect/Engineer for approval before any work which deviates from the original requirements of the drawings and specifications is started. In the event of disagreements as to the necessity of such changes, the decision of the Architect/Engineer shall be final.

1.16 CUTTING AND PATCHING

- A. Provide all necessary cutting and patching, and with approval, to permit the installation of conduit or any part of the work under this branch. The Contractor shall be responsible for any cost caused by defective or ill-timed work. Patching of holes, openings, etc. resulting from the work of this branch shall be provided by this Contractor.

1.17 STANDARDS, CODES AND PERMITS

- A. All work and materials are to conform in every detail to applicable rules and requirements of National, State and Local electrical codes, laws, ordinances, and regulations. Comply with all applicable OSHA regulations.
- B. Conform with other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

- C. All Division 16 work shall be done under the direction of a currently State Certified Master Electrician.
- D. All materials shall have a U.L. label where a U.L. standard and/or test exists.
- E. Prepare and submit to all authorities having jurisdiction, for their approval, all applications and working drawings required by them. Secure and pay for all permits and licenses required.
- F. Abbreviations of standards organizations referenced in this and other sections are as follows:
 - 1. ANSI American National Standards Institute
 - 2. ASTM American Society for Testing and Materials
 - 3. EPA Environmental Protection Agency
 - 4. ETL Electrical Testing Laboratories, Inc.
 - 5. IEEE Institute of Electrical and Electronics Engineers
 - 6. IES Illuminating Engineering Society
 - 7. ISA Instrument Society of America
 - 8. NBS National Bureau of Standards
 - 9. NEC National Electric Code
 - 10. NEMA National Electrical Manufacturers Association
 - 11. NESC National Electrical Safety Code
 - 12. NFPA National Fire Protection Association
 - 13. UL Underwriters Laboratories Inc.

1.18 CLEAN-UP

- A. Refer to Division 1, General Requirements, Cleaning for additional requirements.
- B. This Contractor shall at all times keep the premises free from excessive accumulation of waste material or rubbish resulting from his work, including tools, scaffolding and surplus materials, and he shall leave his work broom-clean or its equivalent. In case of disputes, the Architect may order the removal of such rubbish and charge the cost to the responsible contractor as determined by the Architect/Engineer. At the time of final clean-up all fixtures and equipment shall be thoroughly cleaned and left in proper condition for their intended use.
- C. The Contractor shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

1.19 TESTS

- A. General: The Contractor shall provide all instrumentation, labor and conduct all tests required by the Architect. All tests shall be made before any circuit or item

of equipment is permanently energized. Circuits shall be phased out and loads shall be distributed as evenly as possible on all phases. All phase conductors shall be entirely free from grounds and short circuits. All instrumentation and personnel required for testing shall be provided by the Contractor and all tests shall be conducted in the presence of the Architect or his authorized representative.

B. System Tests:

1. Service and building ground tests.
2. Secondary feeders shall have an insulation resistance test utilizing a megger applying a test potential of 500 volts DC minimum.
3. Establish secondary phase to ground voltages.
4. Set transformer taps to deliver nominal rated voltage.
5. Establish proper phase relationship and motor rotation.

The following tests are required under normal load condition:

6. Record secondary phase to phase and phase to ground voltages and phase currents at all major equipment, apparatus, and on all secondary feeders. Voltage readings shall be taken at line side terminals of distribution centers and panelboards.
7. Confirm proper phase relationship and motor rotation.
8. Confirm load balance at distribution centers and panels. Rebalance load if necessary such that the minimum unbalance between phases shall not exceed 7-1/2%.
9. Reset transformer taps if necessary to deliver nominal rated voltage. Identify final tap settings on transformers nameplates.
10. Confirm operation of all electrically operated apparatus, such as circuit breakers, transfer switches, etc., by exercising same under load.
11. Record all settings and calibrations of circuit breakers, transfer switches, transformers, meters, timing devices, etc.

- C. Records: All test data obtained by the Contractor or manufacturer/supplier shall be recorded and filed with the maintenance manual as part of permanent job records. Test data shall include identification of instruments employed, (field test only) condition of test (time, date, weather, etc.), parameters of test, personnel conducting test, and any pertinent information or conditions noted during the test.

1.20 DRAWINGS OF OTHER TRADES

- A. The Contractor shall consult the drawings of the work for the various other trades; field layouts of the parties performing the work of the other trades; their shop drawings, and he shall be governed accordingly in laying out his work.
- B. Specifically examine shop drawings of other trades to confirm voltage, current characteristics, and other wiring requirements for utilization equipment. Bring any discrepancies to the attention of the A/E.

1.21 FIELD MEASUREMENTS

- A. The Contractor shall take all field measurements necessary for his work and shall assume the full responsibility for their accuracy.
- B. Should any structural interferences prevent the installation of the outlets, running of conduits, etc., at points shown on drawings, the necessary minor deviations therefrom, as determined by the Architect, may be permitted. Minor changes in the position of the outlets or equipment if decided upon before any work has been done by the Contractor shall be made without additional charge.

1.22 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

- A. Before submitting a bid, the Contractor shall familiarize himself with all features of the building and site which may affect the execution of his work. No extra payment will be allowed for the failure to obtain this information. As soon as possible but no later than ten (10) days before bid opening, the Contractor shall call the attention of the Architect/Engineer in writing of any materials or apparatus the Contractor believes to be inadequate and/or any necessary items of work omitted. If the Contractor believes there are inadequacies in the specifications or drawings, where clarifications are necessary to complete the project in accordance with the Contract Documents, the Contractor shall clarify these points with the Architect/Engineer before submitting his bid. In lieu of written clarification by addendum, resolve all conflicts in favor of the greater quantity or better quality.

1.23 GUARANTEE

- A. The Contractor shall unconditionally guarantee his work and all components thereof, excluding lamps, for a period of one year from the date of his final payment. He shall remedy any defects in workmanship and repair or replace any faulty equipment which shall appear within the guarantee period to the entire satisfaction of the Owner/Architect at no additional charge.

1.24 TEMPORARY ELECTRIC

- A. Temporary electrical services include all electric service required up to the time of substantial completion.
- B. As soon as contract is awarded, Electrical Contractor will make all arrangements for temporary service. A 120/240 volt, 100 ampere, single phase, 3 wire service shall be extended into the building as work progresses and panels provided as necessary to provide a minimum of two weatherproof sockets per 1000 sq. ft. of floor space. Sockets shall be utilized for interior lighting and small fractional HP motors only. Cost of temporary service shall be by the Electrical Contractor. In

addition, install and maintain lamps as required to provide illumination of 1/4 watt per sq. ft. throughout, or as required by any codes or ordinances. Maintain and replace all defective sockets, fuses and wiring. Remove temporary installation upon completion of permanent service. All temporary wiring shall conform all applicable codes including NEC and OSHA.

- C. Install permanent service as soon as practical.
- D. All contractors shall provide and maintain their own extension cords and additional lamps as required to perform his work properly.
- E. Contractors requiring temporary connections to 3 phase power service and single phase feeders for other than lighting and small fractional horsepower motorized tools shall make arrangement with the Electrical Contractor. Contractors requiring lighting outside of the building shall make their own arrangements with the Electrical Contractor and pay all costs for installation, maintenance and removal. Contractors requiring electrical equipment over one HP, including welders, hoists, heaters and coolers shall make their own arrangements for such service beyond the main switch and shall pay all costs thereof.
- F. No permanent electrical equipment or wiring shall be used for temporary connections, unless authorized by this Section, upon signed order and with approval by the Architect in behalf of the Owner. Such approvals shall not shorten guarantee period.
- G. No permanent electrical equipment or wiring shall be used for temporary connections, unless authorized by this Section, upon signed order and with approval by the Architect in behalf of the Owner. Such approvals shall not shorten guarantee period.

1.25 SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN

- A. Such requests shall be accompanied by three copies of all necessary illustrations, cuts, drawings and descriptions of material proposed for substitution and shall fully describe all points in which it differs from the articles specified. The Engineer will retain two copies and one copy returned to the Contractor with acceptance, rejection or revisions indicated thereon.
- B. The proposed substitution does not affect dimensions shown on Drawings or as specified.
- C. The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.
- D. The all proposed substitutions will be subject to satisfactory performance to the specification and considered as a deduct alternate rather than as an equivalent.

- E. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs, including architectural/engineering design and construction costs, involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- F. All substitution review costs shall be reimburse to the Engineer by the contractor or their suppliers on a Time/Material bases. This cost shall be paid on approval on disapproval of the substitution material, equipment or design.

1.26 WORKMANSHIP

- A. The installation of all work shall be made so that its several component parts will function as a workable system complete with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The work shall be executed in conformity with the best-accepted standard practice of the trade so as to contribute to efficiency and appearance. It shall also be executed so that the installation will conform and adjust itself to the building structure, its equipment and its usage.

1.27 FIELD MEASUREMENTS

- A. The Contractor shall take all field measurements necessary for his work and shall assume the full responsibility for their accuracy.

1.28 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

- A. Before submitting a bid, the Contractor shall visit the site and familiarize himself with all features of the building and site, which may affect the execution of his work. No extra payment will be allowed for the failure to obtain this information. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points with the Engineer before submitting his bid. In lieu of written clarification by addendum, the contractor shall resolve all conflicts in favor of the greater quantity or better quality.

PART 2 – PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of 2 inches o.c., in webs.
- D. Slotted-Steel Channel Supports: Comply with Division 5 Section "Metal Fabrications" for slotted channel framing.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
 - 1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
 - 2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
- F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- I. Expansion Anchors: Carbon-steel wedge or sleeve type.
- J. Toggle Bolts: All-steel springhead type.
- K. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 CONCRETE BASES

- A. Concrete: 3000-psi, 28-day compressive strength.
- B. Provide a 4" housekeeping pad under any floor mounted electrical equipment as directed by the engineer.

2.3 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 – EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- 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. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on

- solid masonry units.
- 3. New Concrete: Concrete inserts with machine screws and bolts.
- 4. Existing Concrete: Expansion bolts.
- 5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
- 6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a) Field Welding: Comply with AWS D1.1.
- 7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
- 8. Light Steel: Sheet-metal screws.
- 9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

- A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.5 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified.

3.6 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.7 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.

3.8 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Electricity-metering components.
 - 6. Concrete bases.
 - 7. Cutting and patching for electrical construction.
 - 8. Touchup painting.
- B. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data
 - 1. Connect a load of known kW rating, 1.5 kW minimum, to a circuit supplied by the metered feeder.
 - 2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.
 - 3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.
 - 4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record test results.
 - 5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

3.9 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "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.

3.10 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.

END OF SECTION 16050

1.2. Section 16060 - Grounding And Bonding

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 grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. Related Sections include the following:
 - 1. Division 2 Section "Underground Ducts and Utility Structures" for ground test wells.
 - 2. Division 16 Section "Lightning Protection" for additional grounding and bonding materials.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Ground rods.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- C. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1. Comply with UL 467.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

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.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."
- B. Material: Copper Only.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- G. Bare Copper Conductors: Comply with the following:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Assembly of Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
- H. Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Sectional type; stainless steel.
 1. Size: 3/4 by 120 inches in diameter.
- B. Test Wells: Provide handholes as specified in Division 2 Section "Underground Ducts and Utility Structures."

PART 3 – EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.
- F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.

2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.
- G. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding 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. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- G. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- H. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

- I. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- J. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.
- K. Common Ground Bonding 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.

3.3 COUNTERPOISE

- A. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 10 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 2/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18 inches below grade and 24 inches from building foundation.

3.4 INSTALLATION

- A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
 - 1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps

directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

- D. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- H. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.
- I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, Paragraph 250-81(c), using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.5 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. 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 to 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.

- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.
- F. Tighten screws and bolts for grounding and bonding 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.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2/0 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.7 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests, by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each 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.
 - a) Equipment Rated 500 kVA and Less: 10 ohms.
 - b) Equipment Rated 500 to 1000 kVA: 5 ohms.
 - c) Equipment Rated More Than 1000 kVA: 3 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance.

END OF SECTION 16060

1.3. Section 16075 - Electrical Identification

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 electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate color, lettering style, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 – PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on white field.
 - 2. Legend: Indicates voltage and service.

- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.
- C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
- D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- E. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend indicating type of underground line.
- F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- G. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.
- H. Brass or Aluminum Tags: 2 by 2 by 0.05-inch metal tags with stamped legend, punched for fastener.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.
 - 1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
 - 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
 - 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
 - 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. Circuits with More Than 600 V: Identify raceway and cable with "DANGER--HIGH VOLTAGE" in black letters 2 inches high, stenciled with paint at 10-foot intervals over a continuous, painted orange background. Identify the following:
 - 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 envelope around conduits in vertical shafts, exposed in the building, or concealed above suspended ceilings.

4. Entire surface of exposed conduits.
- F. Install painted identification according to manufacturer's written instructions and as follows:
1. Clean surfaces of dust, loose material, and oily films before painting.
 2. Prime surfaces using type of primer specified for surface.
 3. Apply one intermediate and one finish coat of enamel.
- G. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
 3. Apply the following colors to the systems listed below:
 - a) Fire Alarm System: Red.
 - b) Fire-Suppression Supervisory and Control System: Red and yellow.
 - c) Combined Fire Alarm and Security System: Red and blue.
 - d) Security System: Blue and yellow.
 - e) Mechanical and Electrical Supervisory System: Green and blue.
 - f) Telecommunication System: Green and yellow.
- H. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- I. Circuit Identification Labels on Boxes: Install labels externally.
1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 2. Concealed Boxes: Plasticized card-stock tags.
 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- J. Paths of Underground Electrical Lines: During trench backfilling, 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 finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
- K. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder phase conductors:
1. 208240/120-V Conductors:

- a) Phase A: Black.
 - b) Phase B: Red.
 - c) Phase C: Blue.
 - 2. 480/277-V Conductors:
 - a) Phase A: Yellow.
 - b) Phase B: Brown.
 - c) Phase C: Orange.
 - 3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a) Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b) Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- L. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
- 1. Legend: 1/4-inch- steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 - 2. Tag Fasteners: Nylon cable ties.
 - 3. Band Fasteners: Integral ears.
- M. Apply identification to conductors as follows:
- 1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 - 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 - 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- N. Apply warning, caution, and instruction signs as follows:
- 1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 - 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- high lettering for emergency

instructions on power transfer, load shedding, and other emergency operations.

- O. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- high lettering on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Electrical switchgear and switchboards.
 4. Electrical substations.
 5. Emergency system boxes and enclosures.
 6. Motor-control centers.
 7. Disconnect switches.
 8. Enclosed circuit breakers.
 9. Motor starters.
 10. Push-button stations.
 11. Power transfer equipment.
 12. Contactors.
 13. Remote-controlled switches.
 14. Dimmers.
 15. Control devices.
 16. Transformers.
 17. Inverters.
 18. Rectifiers.
 19. Frequency converters.
 20. Battery racks.
 21. Power-generating units.
 22. Telephone switching equipment.
 23. Clock/program master equipment.
 24. Call system master station.
 25. TV/audio-monitoring master station.
 26. Fire alarm master station or system control panel.
 27. Security-monitoring master station or control panel.

END OF SECTION 16075

1.4. Section 16120 - Conductors And Cables

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 building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 16 Section "Control/Signal Transmission Media" for transmission media used for control and signal circuits.
 - 2. Division 16 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

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

2.2 CONDUCTORS AND CABLES

- A. Manufacturers:
 - 1. Alcan Aluminum Corporation; Alcan Cable Div.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper complying with NEMA WC 5 ; stranded conductor.
- D. Conductor Insulation Types: Type THHN-THWN UF USE and SO complying with NEMA WC 5 .
- E. Multiconductor Cable: Metal-clad cable, Type MC Type SO and Type USE with ground wire.

2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. AMP Incorporated/Tyco International.
 - 3. Hubbell/Anderson.
 - 4. O-Z/Gedney; EGS Electrical Group LLC.
 - 5. 3M Company; Electrical Products Division.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 – EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in metallic raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- H. Underground Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.
- I. Type UF multiconductor cable, use direct burial..
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- K. Fire Alarm Circuits: Power-limited, fire-protective, signaling circuit cable.
- L. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- M. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."
- F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- G. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.4 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
- B. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 16120

1.5. Section 16130 - Raceways And Boxes

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 7 Section "Through-Penetration Firestop Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 2. Division 16 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
 - 3. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. LFNC: Liquidtight flexible nonmetallic conduit.
- F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: Show fabrication and installation details of components for

raceways, fittings, boxes, enclosures, and cabinets.

- C. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 2. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Location of all feeders. Raceway and pull boxes as listed below:
 - a) Main service conduits/boxes.
 - b) Distribution conduits/boxes.
 - c) Motor conduits (above 1”).

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Equipment conduit/boxes (above 30 amp's in size).
- D. Location of all disconnects/motor starter and mounting method.
- E. Location of all distribution/branch circuit feeders, pull boxes and panelboards.
- F. Location of all floor boxes and under floor conduits.
- G. Dimension plan of all floor boxes and floor power feeds.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

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 METAL CONDUIT AND TUBING

- A. Manufacturer:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- F. Plastic-Coated IMC and Fittings: NEMA RN 1.
- G. EMT and Fittings: ANSI C80.3.
- H. FMC: Zinc-coated steel.
- I. LFMC: Flexible steel conduit with PVC jacket.
- J. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturer:
 - 1. American International.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arnco Corp.

4. Cantex Inc.
 5. Certainteed Corp.; Pipe & Plastics Group.
 6. Condux International.
 7. ElecSYS, Inc.
 8. Electri-Flex Co.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT/Cole-Flex.
 11. RACO; Division of Hubbell, Inc.
 12. Spiralduct, Inc./AFC Cable Systems, Inc.
 13. Thomas & Betts Corporation.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
- E. LFNC: UL 1660.

2.4 METAL WIREWAYS

- A. Manufacturer:
1. Hoffman.
 2. Square D.
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 3R.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Hinged type Flanged-and-gasketed type.
- F. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
1. Manufacturer:
 - a) Airey-Thompson Sentinel Lighting; Wiremold Company (The).

- b) Thomas & Betts Corporation.
 - c) Walker Systems, Inc.; Wiremold Company (The).
 - d) Wiremold Company (The); Electrical Sales Division.
- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturer:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. Emerson/General Signal; Appleton Electric Company.
 - 3. Erickson Electrical Equipment Co.
 - 4. Hoffman.
 - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - 6. O-Z/Gedney; Unit of General Signal.
 - 7. RACO; Division of Hubbell, Inc.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet-PLM Division.
 - 10. Spring City Electrical Manufacturing Co.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Floor Boxes: Cast metal, fully adjustable, rectangular.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key

latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.7 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard grey paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors:
 - 1. Exposed: Rigid steel or IMC.
 - 2. Concealed: Rigid steel or IMC.
 - 3. Underground, Single Run: RNC.
 - 4. Underground, Grouped: RNC.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 3R.
- B. Indoors:
 - 1. Exposed: EMT.
 - 2. Concealed: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 - 4. Damp or Wet Locations: Rigid steel conduit.
 - 5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a) Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. EMT Conduit: Use steel set screw or compression.
 - 2. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated. Type with insulated throat (no cast).
 - 3. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete,

install in nonmetallic sleeve.

- F. Do not install aluminum conduits embedded in or in contact with concrete.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
- K. Tighten set screws of threadless fittings with suitable tools.
- L. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- N. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- Q. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- R. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

- S. Set floor boxes level and flush with finished floor surface.
- T. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- U. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- V. Outlets:
 - 1. Locations of outlets and electrical equipment on the drawings are approximate only. Unless otherwise indicated on the drawings or established in the specifications, the exact locations of electrical outlets shall be established in the field by directive from the Architect. Generally, outlets shall be located as required for proper installation of equipment served and otherwise locations shall be established by construction or code requirements and such as to be coordinated with equipment of other trades.
 - 2. This Section shall consult with the Architect and refer to all details, sections, elevations and equipment plans and the plans of other trades for exact location.
 - 3. The Architect reserves the right to make reasonable changes in the location of outlets, apparatus or equipment up to the time of roughing in. Such changes as directed shall be made by the Contractor without additional compensation.
 - 4. Dimensions taken by scale shall not be used to establish rough-in locations.
 - 5. No back-to-back units, offset outlet boxes on opposite side of wall a minimum of 12 inches.
- W. Wiring Devices:
 - 1. The approximate location of wiring devices are indicated on the drawings; the specific locations shall be determined in accordance with "Location of Outlets" of these specifications and as follows.
 - 2. This section is referred to equipment plans, equipment shop drawings, elevation drawings and other detail or dimensional drawings, and he shall consult with the Architect before installation of outlet boxes for wiring devices or before proceeding with any work dependent upon this information.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 16130

1.6. Section 16140 - Wiring Devices

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
 - 2. Single-, double-pole, 3-way and 4-way snap switches and dimmer switches.
 - 3. Device wall plates.
 - 4. Pin and sleeve connectors and receptacles.
 - 5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 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: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wiring Devices:
 - a) Cooper Wiring Devices/Bryant Electric, Inc./Hubbell Subsidiary.
 - b) Eagle Electric Manufacturing Co., Inc.
 - c) Hubbell Incorporated; Wiring Device-Kellems.
 - d) Leviton Mfg. Company Inc.
 - e) Pass & Seymour/Legrand; Wiring Devices Div.
 - 2. Wiring Devices for Hazardous (Classified) Locations:
 - a) Crouse-Hinds/Cooper Industries, Inc.; Arrow Hart Wiring Devices..
 - b) EGS/Appleton Electric Company.
 - c) Killark Electric Manufacturing Co./Hubbell Incorporated.
 - 3. Multioutlet Assemblies:
 - a) Hubbell Incorporated; Wiring Device-Kellems.
 - b) Wiremold Company (The).
 - 4. Poke-Through, Floor Service Outlets and Telephone/Power Poles:
 - a) Hubbell Incorporated; Wiring Device-Kellems.
 - b) Pass & Seymour/Legrand; Wiring Devices Div.
 - c) Wiremold Company (The).

2.2 RECEPTACLES

- A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- C. Straight-Blade Receptacles: Hospital Heavy –Duty Industrial grade.
- D. GFCI Receptacles: Straight blade, non-feed-through type, Hospital grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- deep outlet box without an adapter.
- E. Isolated-Ground Receptacles: Straight blade, Hospital grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
 - 1. Devices: Listed and labeled as isolated-ground receptacles.
 - 2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.
- F. TVSS Receptacles: Straight blade, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.
 - 1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.
 - 2. Active TVSS Indication: Visual only with light visible in face of device to indicate device is "active" or "no longer in service."
 - 3. Receptacle Type: Hospital grade, with isolated-ground terminal.
 - 4. Identification: Distinctive marking on face of device to denote TVSS-type unit.
- G. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.
- H. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.3 PENDANT CORD/CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 SWITCHES

- A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- B. Snap Switches: Heavy -Duty grade, quiet type.
- C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
 - 1. Switch: 20 A, 120/277-V ac.
 - 2. Receptacle: NEMA WD 6, Configuration 5-15R.
- D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
 - 1. Control: Continuously adjustable slider toggle switch; with single-pole or three-way switching to suit connections.
 - 2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch wire connecting leads.
 - 3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.4 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch- thick, satin-finished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

2.5 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 5 jacks for UTP cable.

2.6 POKE-THROUGH ASSEMBLIES

- A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
 - 1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.
 - 2. Size: Selected to fit nominal cored holes in floor and matched to floor thickness.
 - 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 4. Closure Plug: Arranged to close unused cored openings and reestablish fire rating of floor.
 - 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of four, 4-pair, Category 5 voice and data communication cables.

2.7 MULTIOUTLET ASSEMBLIES

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish.
- C. Wire: No. 12 AWG.

2.8 SERVICE POLES

- A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch- square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
3. Finishes: Satin anodized-aluminum.
4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors; and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6, Configuration 5-20R units.
6. Voice and Data Communication Outlets: Four RJ-45 Category 5 jacks.

2.9 FINISHES

- A. Color:
 1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70.
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. TVSS Devices: Blue.
 4. Isolated-Ground Receptacles: Orange.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.
- C. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
- D. Wrap wiring devices with insulating tape before installing and placing plates.
- E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- F. Remove wall plates and protect devices and assemblies during painting.
- G. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 16 Section "Electrical Identification."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 16140

1.7. Section 16145 - Lighting Control Devices

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Outdoor and indoor photoelectric switches.
 - 3. Switch-box occupancy sensors.
 - 4. Indoor occupancy sensors.
 - 5. Outdoor motion sensors.
 - 6. Multipole contactors.
- B. Related Sections include the following:
 - 1. Division 16 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Lighting plan showing location, orientation, and coverage area of each sensor.
 - 2. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 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.

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 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

- A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.3 TIME SWITCHES

- A. Manufacturers:
 - 1. Intermatic, Inc.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lithonia Lighting.
 - 4. Paragon Electric Co.
 - 5. Square D.
 - 6. TORK.
 - 7. Touchplate Technologies, Inc.
 - 8. Watt Stopper (The).
- B. Digital Time Switches: Electronic, solid-state programmable units with alphanumeric display complying with UL 917.
 - 1. Contact Configuration: As indicated.
 - 2. Contact Rating: 20-A ballast load, 120/240-V ac.

3. Program: Single channel, 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
4. Programs: Channels.
 - a) For each channel, 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
 - b) For each channel, 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
 - c) For each channel, 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
5. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program on selected channels.
6. Astronomical Time: All channels.
7. Battery Backup: For schedules and time clock.

2.4 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers:
 1. Intermatic, Inc.
 2. Lithonia Lighting.
 3. Paragon Electric Co.
 4. TORK.
 5. Touchplate Technologies, Inc.
 6. Watt Stopper (The).
- B. Description: Solid state, with DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; and complying with UL 773.
 1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 2. Time Delay: 15-second minimum, to prevent false operation.
 3. Lightning Arrester: Air-gap type.
 4. Mounting: Twist lock complying with IEEE C136.10, with base. Provide with stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

2.5 INDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers:
 1. Intermatic, Inc.
 2. Lithonia Lighting.
 3. MicroLite Corporation.
 4. Paragon Electric Co.
 5. Square D.
 6. TORK.
 7. Touchplate Technologies, Inc.
 8. Watt Stopper (The).

- B. Ceiling-Mounting Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 5. Indicator: Two LEDs to indicate the beginning of on and off cycles.
- C. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 3. Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.
 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 5. Indicator: Two LEDs to indicate the beginning of on and off cycles.

2.6 SWITCH-BOX OCCUPANCY SENSORS

- A. Manufacturers:
1. Lithonia Lighting.
 2. MYTECH Corporation.
 3. TORK.
 4. Unenco Electronics; a Hubbell Company.
 5. Watt Stopper (The).
- B. Description: PIR type with integral power-switching contacts rated for 800 W at 120-V ac, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/6-hp motors; and rated for 1000 W at 277-V ac, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/3-hp motors, minimum.

1. Include ground wire.
2. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keeps lighting off when selected lighting level is present.

2.7 INDOOR OCCUPANCY SENSORS

- A. Manufacturers:
 1. Lithonia Lighting.
 2. MYTECH Corporation.
 3. Unenco Electronics; a Hubbell Company.
 4. Watt Stopper (The).
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a) Sensor: Suitable for mounting in any position on a standard outlet box.
 - b) Relay: Externally mounted though a 1/2-inch knockout in a standard electrical enclosure.
 - c) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keeps lighting off when selected lighting level is present.
- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
 1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in..
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.

- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving at least 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on an 8-foot- high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
- E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in., and detect a person of average size and weight moving at least 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.8 OUTDOOR MOTION SENSORS (PIR)

- A. Manufacturers:
1. Lithonia Lighting.
 2. Paragon Electric Co.
 3. RAB Electric Manufacturing, Inc.
 4. TORC.
 5. Watt Stopper (The).
- B. General Description: Suitable for operation in ambient temperatures ranging from minus 40 deg F to 130 deg F, UL 773A rated as raintight.
1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Suitable for switching 300 W of tungsten load at 120- or 277-V ac. Lampholders shall comply with UL 1571
 3. for wet locations.

4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 5. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 6. Mounting:
 - a) Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b) Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 7. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 8. Bypass Switch: Override the on function in case of sensor failure.
 9. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keeps lighting off during daylight hours.
- C. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in.
- D. Detection Coverage: Up to 100 feet, with a field of view of 60 degrees.

2.9 MULTIPOLE CONTACTORS

- A. Manufacturers:
1. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 3. Cutler-Hammer; Eaton Corporation.
 4. GE Industrial Systems; Total Lighting Control.
 5. Grasslin Controls Corporation.
 6. MicroLite Corporation.
 7. TORK.
 8. Touchplate Technologies, Inc.
 9. Watt Stopper (The).
- B. Description: Electrically operated and electrically held, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Control-Coil Voltage: Match control power source.

2.10 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 16 Section "Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Division 16 Section "Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 14 AWG, complying with Division 16 Section "Conductors and Cables."
- D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 16 Section "Voice and Data Communication Cabling."

PART 3 – EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."
- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where test results 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.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 16145

1.8. Section 16410 - Enclosed Switches And Circuit Breakers

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 individually mounted enclosed switches and circuit breakers used for the following:
 - 1. Service disconnecting means.
 - 2. Feeder and branch-circuit protection.
 - 3. Motor and equipment disconnecting means.
- B. Related Sections include the following:
 - 1. Division 16 Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. RMS: Root mean square.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switch and circuit breaker.
 - 1. 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) Enclosure types and details for types other than NEMA 250, Type 1.
 - b) Current and voltage ratings.
 - c) Short-circuit current rating.
 - d) UL listing for series rating of installed devices.

- e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- C. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in "Quality Assurance" Article.
- D. Field Test Reports: Submit written test reports and include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.
- F. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for components.
 - 2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
 - 3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA AB 1 and NEMA KS 1.
- D. Comply with NFPA 70.
- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between

enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Fusible Switches:
 - a) Eaton Corp.; Cutler-Hammer Products.
 - b) General Electric Co.; Electrical Distribution & Control Division.
 - c) Square D Co.
 - 2. Molded-Case Circuit Breakers:
 - a) Eaton Corp.; Cutler-Hammer Products.
 - b) General Electric Co.; Electrical Distribution & Control Division.
 - c) Square D Co.
 - 3. Combination Circuit Breaker and Ground-Fault Trip:
 - a) Eaton Corp.; Cutler-Hammer Products.
 - b) General Electric Co.; Electrical Distribution & Control Division.
 - c) Square D Co.
 - 4. Molded-Case, Current-Limiting Circuit Breakers:
 - a) Eaton Corp.; Cutler-Hammer Products.
 - b) General Electric Co.; Electrical Distribution & Control Division.
 - c) Square D Co.
 - 5. Integrally Fused, Molded-Case Circuit Breakers:
 - a) Eaton Corp.; Cutler-Hammer Products.

- b) General Electric Co.; Electrical Distribution & Control Division.
- c) Square D Co.

2.2 ENCLOSED SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. Molded-Case Circuit Breaker: NEMA AB 1, 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 Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a) Instantaneous trip.
 - b) Long- and short-time pickup levels.
 - c) Long- and short-time time adjustments.
 - d) Ground-fault pickup level, time delay, and I²t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 - 6. GFCI Circuit Breakers: Single- and two-pole configurations with 5 -mA trip sensitivity.
 - 7. Molded-Case Switch: Molded-case circuit breaker without trip units.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional with field-adjustable 0.1- to 0.6-second time delay.
7. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 1. Outdoor Locations: NEMA 250, Type 3R.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

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. PROCEED WITH INSTALLATION ONLY AFTER UNSATISFACTORY CONDITIONS HAVE BEEN CORRECTED
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."

- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
 - 2. Test continuity of each line- and load-side circuit.
- B. Testing Agency: Owner will engage a qualified independent testing agency to perform specified testing.
- C. Testing Agency: Engage a qualified independent testing agency to perform specified testing.
- D. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies switches and circuit breakers checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of enclosures. 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 16410

1.9. Section 16420 - Enclosed Controllers

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 ac general-purpose controllers rated 600 V and less that are supplied as enclosed units.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
 - 1. 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) Enclosure types and details.
 - b) Nameplate legends.
 - c) Short-circuit current rating of integrated unit.
 - d) UL listing for series rating of overcurrent protective devices in combination controllers.
 - e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- C. Field Test Reports: Written reports specified in Part 3.
- D. Manufacturer's field service report.
- E. Maintenance Data: For enclosed controllers and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and all installed components.

- F. 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.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency with the experience and capability to satisfactorily conduct the testing indicated, as documented according to ASTM E 548.
- B. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subjected to weather, cover enclosed controllers to protect 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.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with utility interruptions without Architect's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required

workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller 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. 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Manual and Magnetic Enclosed Controllers:
 - a) ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - b) Eaton Corp.; Cutler-Hammer Products.
 - c) General Electrical Distribution & Control.
 - d) Rockwell Automation Allen-Bradley Co.; Industrial Control Group.
 - e) Square D Co.

2.2 MANUAL ENCLOSED CONTROLLERS

- A. Description: NEMA ICS 2, general purpose, Class A, with toggle action and overload element.

2.3 MAGNETIC ENCLOSED CONTROLLERS

- A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
- B. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

- C. Combination Controller: Factory-assembled combination controller and disconnect switch.
 - 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.
 - 2. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- E. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
 - 1. Compelling relay to ensure motor will start only at low speed.
 - 2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
 - 3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.4 ENCLOSURES

- A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.

- E. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.
- F. Current-Sensing, Phase-Failure Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.6 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. See Division 16 Section "Basic Electrical Materials and Methods" for general installation requirements.
- B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 16 Section "Basic Electrical Materials and Methods."
- C. Enclosed Controller Fuses: Install fuses in each fusible switch.

3.4 IDENTIFICATION

- A. Identify enclosed controller components and control wiring according to Division 16 Section "Electrical Identification."

3.5 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Testing: Perform the following field quality-control testing:
 - 1. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16.
 - 2. Certify compliance with test parameters.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting solid-state controllers.
- D. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.7 CLEANING

- A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that enclosed controllers are installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections.
- D. Complete installation and startup checks according to manufacturer's written instructions.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers and variable-frequency drives.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 16420

1.10. Section 16442 - Panelboards

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Transient voltage suppression panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, 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. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a) Enclosure types and details for types other than NEMA 250, Type 1.
 - b) Bus configuration, current, and voltage ratings.
 - c) Short-circuit current rating of panelboards and overcurrent protective devices.
 - d) UL listing for series rating of installed devices.

- e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - f) Coordination drawing of location and layout.
- 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," 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.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- D. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

- E. 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.
- F. Comply with NEMA PB 1.
- G. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Architect's written permission.

1.7 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, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a) Eaton Corporation; Cutler-Hammer Products.
 - b) General Electric Co.; Electrical Distribution & Protection Div.
 - c) Square D.
2. Transient Voltage Suppression Panelboards:
 - a) Current Technology.
 - b) Liebert Corporation.

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Seismic Controls for Electrical Work."
- B. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
 1. Rated for environmental conditions at installed location.
 - a) Outdoor Locations: NEMA 250, Type 3R.
 - b) Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - c) Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d) Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 6. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
 7. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 8. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- C. Phase and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
 3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 5. Split Bus: Vertical buses divided into individual vertical sections.

- D. Conductor Connectors: Suitable for use with conductor material.
 - 1. Main and Neutral Lugs: Mechanical type.
 - 2. Ground Lugs and Bus Configured Terminators: Compression type.
 - 3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
- B. Main Overcurrent Protective Devices: Circuit breaker.
- C. Branch Overcurrent Protective Devices:
 - 1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - 2. 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.
 - 3. Fused switches.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 TRANSIENT VOLTAGE SUPPRESSION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- B. Main Overcurrent Devices: Thermal-magnetic circuit breaker.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.
- D. Bus: Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
- E. Transient Voltage Suppression Device: IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.
 - 1. Minimum Single-Impulse Current Ratings:
 - a) Line to Neutral: 100,000 A.
 - b) Line to Ground: 100,000 A.
 - c) Neutral to Ground: 50,000 A.
 - 2. Protection modes shall be as follows:
 - a) Line to neutral.
 - b) Line to ground.
 - c) Neutral to ground.
 - 3. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
 - 4. Maximum Category C Combination Wave Clamping Voltage: [6500 V, line to neutral and line to ground on 120/20840 V] [1000 V, line to neutral and line to ground on 277/480 V] systems.
 - 5. Maximum UL 1449 Clamping Levels: [400 V, line to neutral and line to ground on 120/20840 V] [800 V, line to neutral and line to ground on 277/480 V] systems.
 - 6. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
 - 7. Accessories:
 - a) Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
 - b) Audible alarm activated on failure of any surge diversion module.
 - c) Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.7 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: 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-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
 - a) Instantaneous trip.
 - b) Long- and short-time pickup levels.
 - c) Long- and short-time time adjustments.
 - d) Ground-fault pickup level, time delay, and I²t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with [5] [30]-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."
5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
7. 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.
8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
10. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- D. Fuses are specified in Division 16 Section "Fuses."

2.8 CONTROLLERS

- A. Motor Controllers: NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:
 - 1. Individual control-power transformers.
 - 2. Fuses for control-power transformers.
 - 3. Melting-alloy overload relay.
 - 4. Indicating lights.
 - 5. Seal-in contact.
 - 6. 2 convertible auxiliary contacts.
 - 7. Push buttons.
 - 8. Selector switches.
- B. Contactors: NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:
 - 1. Individual control-power transformers.
 - 2. Fuses for control-power transformers.
 - 3. Indicating lights.
 - 4. Seal-in contact.
 - 5. 2 convertible auxiliary contacts.
 - 6. Push buttons.
 - 7. Selector switches.
- C. Controller Disconnect Switches: Adjustable instantaneous-trip circuit breaker integrally mounted and interlocked with controller.
 - 1. Auxiliary Contacts: Integral with disconnect switches to de-energize external control-power source.
- D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller.
 - 1. Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. Control-Power Source: 120-V branch circuit.

2.9 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

- B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.
- C. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."
- C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 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.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 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 16442

1.11. Section 16511 - Interior Lighting

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures with lamps and ballasts.
 - 2. Lighting fixtures mounted on exterior building surfaces.
 - 3. Emergency lighting units.
 - 4. Exit signs.
 - 5. Accessories, including fluorescent fixture dimmers and occupancy sensors.
- B. Related Sections include the following:
 - 1. Division 16 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
 - 2. Division 16 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
- B. CRI: Color rendering index.
- C. CU: Coefficient of utilization.
- D. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:
 - 1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.
- E. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of fixture, including dimensions and verification of indicated parameters.
 - 2. Emergency lighting unit battery and charger.
 - 3. Fluorescent and high-intensity-discharge ballasts.
 - 4. Air and Thermal Performance Data: For air-handling fixtures. Furnish data required in "Submittals" Article in Division 15 Section "Diffusers, Registers, and Grilles."
 - 5. Sound Performance Data: For air-handling fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 15 Section "Diffusers, Registers and Grilles."
 - 6. Lamps.
 - 7. Unit pricing on fixture as specified, and 15' of appropriate pipe and wiring.
 - 8. Complete fixture catalog number designation.
- B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. Wiring Diagrams: Power, signal, and control wiring.
- D. Coordination Drawings: Reflected ceiling plan(s) 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. Suspended ceiling components.
 - 2. Structural members to which lighting-fixture suspension systems will be attached.
 - 3. Other items in finished ceiling, including the following:
 - a) Air outlets and inlets.
 - b) Speakers.
 - c) Sprinklers.
 - d) Access panels.
 - 4. Perimeter moldings.
- E. Samples for Verification: For interior lighting fixtures designated for sample submission in the Interior Lighting Fixture Schedule – upon request by A/E..
 - 1. Lamps: Specified units installed.
 - 2. Ballast: 120-V models of specified ballast types.
 - 3. Accessories: Cords and plugs.

- F. Product Certificates: For each type of ballast for dimmer-controlled fixtures, signed by product manufacturer.
- G. Source quality-control test reports.
- H. Field quality-control test reports.
- I. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.
- J. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.
- E. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- F. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.
- G. Mockups: Provide lighting fixtures for room or module mockups. Install fixtures for mockups with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 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.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Unit 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: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
- B. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

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. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 FIXTURES AND COMPONENTS, GENERAL

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

- B. Incandescent Fixtures: Comply with UL 157198. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 157098. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 157298. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. 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.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a) Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
 - b) UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.
- J. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 15 Section "Diffusers, Registers, and Grilles."
 - 1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
 - 2. Heat Removal Units: Air path leads through lamp cavity.
 - 3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
 - 4. Dampers: Operable from outside fixture for control of return-air volume.

5. Static Fixtures: Air supply slots are blanked off, and fixture appearance matches active units.

2.3 FLUORESCENT LAMP BALLASTS

- A. Description: Include the following features, unless otherwise indicated:
 1. Designed for type and quantity of lamps indicated at full light output except for emergency lamps powered by in-fixture battery-packs.
- B. Electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:
 1. Comply with NEMA C82.11.
 2. Ballast Type: Program Start.
 3. Programmed Rapid-Start: Ballasts utilize a micro-controller based circuit to apply a precise amount of cathode heat prior to starting the lamp. This ensures that the cathodes have reached optimum temperature before the lamp is started. Once the lamp is ignited, the ballast reduces the amount of cathode heat to the optimum level, to assure long lamp life.
 4. Sound Rating: A.
 5. Total harmonic distortion rating of less than 10 percent according to NEMA C82.11.
 6. Transient Voltage Protection: IEEE C62.41, Category A.
 7. Operating Frequency: 40 kHz or higher.
 8. Lamp Current Crest Factor: Less than 1.7.
 9. Ballast Factor (BF): .87 or higher.
 10. Power Factor (PF): .97% or higher.
 11. Series Lamp Circuits.
 12. Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.
 13. Universal Voltage: Ballasts shall operate from 120V through 277V.
 14. Starting Temperature: Minimum 0 degree F starting temperature for standard interior applications.
 15. Ballasts shall provide end-of-life (EOL) protection circuitry.
- C. Ballasts for compact lamps in recessed fixtures shall have the following features, unless otherwise indicated:
 1. Type: Electronic .
 2. Power Factor: 90 percent, minimum.
 3. Flicker: Less than 5 percent.
 4. Lamp Current Crest Factor: Less than 1.7.
 5. Electronic Ballast Operating Frequency: 40kHz or higher.
 6. Lamp end-of-life detection and shutdown circuit.
 7. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.

8. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
- D. Ballasts for compact lamps in nonrecessed fixtures shall include the following features, unless otherwise indicated:
1. Power Factor: 90 percent, minimum.
 2. Ballast Coil Temperature: 65 deg C, maximum.
 3. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
 4. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
- E. Ballasts for dimmer-controlled fixtures shall comply with general and fixture-related requirements above for electronic ballasts and the following features:
1. Ballast shall be Program Start, Electronic Dimming type.
 2. Dimming Range: Minimum 100 to 5 percent of rated lamp lumens.
 3. Ballast Input Watts: Can be reduced to 20 percent of normal.
 4. Compatibility: Certified by manufacturer for use with specific dimming system indicated.
 5. Lamp Connection: Series
 6. Ballast shall have a Power Factor greater than 0.98 at full light output and greater than 0.90 throughout the dimming range for primary lamp.
 7. Ballast shall be high frequency electronic type and operate lamps at frequency above 40 kHz to avoid interference with infrared devices.
 8. Ballast shall be universal voltage type which operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.
- F. Ballasts for Low-Temperature Environments:
1. Temperatures 0 deg F and Higher: Electronic type rated for 0 deg F minus 17 deg C starting temperature.
 2. Temperatures Minus 20 deg F minus 29 deg C and Higher: Electromagnetic type designed for use with high-output lamps.
- G. Ballasts shall all be suitable for low electromagnetic-interference and comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic (EMI) and radio-frequency interference (RFI) for Class A non-consumer equipment.

2.4 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

- A. General: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated.
1. Type: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F, Minus 30 deg C for single-lamp ballasts.
 3. Normal Ambient Operating Temperature: 104 deg F, 40 deg C.
 4. Open-circuit operation that will not reduce average life.
- B. Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.
- C. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
- D. High-Pressure-Sodium Ballasts: Solid-state igniter/starter with an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
1. Instant Restrike Device: Solid-state potted module, mounted inside high-pressure-sodium fixture and compatible with high-pressure-sodium lamps, ballasts, and sockets up to 150 W.
 - a) Restrike Range: 105- to 130-V ac.
 - b) Maximum Voltage: 250-V peak or 150-V ac RMS.

2.5 EXIT SIGNS

- A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
1. Contractor shall provide ten percent of total exit signs to be installed at the direction of the A/E, or the authority having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: Incandescent, 2 for each fixture, 50,000 hours of rated lamp life.
 2. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
 3. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.
 4. Additional Lamps for DC Operation: Two minimum, bayonet-base type, for connection to external dc source.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal

voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

2.6 EMERGENCY LIGHTING UNITS

- A. General: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid/nickel cadmium type with minimum 10-year nominal life and special warranty.
 - 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. Wire Guard: Where indicated, heavy-chrome-plated wire guard protects lamp heads or fixtures.
 - 5. Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.
 - 6. Contractor shall provide ten percent of total emergency lighting units to be installed at the direction of the A/E or authority having jurisdiction.
 - 7. FLUORESCENT EMERGENCY LIGHTING FIXTURES
- B. Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.
 - 1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 - 2. Night Light Connection: Operate one fluorescent lamp continuously.
 - 3. Test Switch and Light-Emitting-Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - 4. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum seven-year nominal life.
 - 5. Charger: Fully automatic, solid-state, constant-current type.
- C. Central Type: Factory installed, full light output, fluorescent emergency ballast to operate lamps indicated from a remote emergency power source.
- D. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from light fixture. Comply with UL 924.
 - 1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Night Light Connection: Operate one fluorescent lamp in a remote fixture continuously.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum seven-year nominal life.
 4. Charger: Fully automatic, solid-state, constant-current type.
 5. Housing: NEMA 250, Class 1 enclosure.
- E. Contractor shall provide ten percent of total battery-inverter units to be installed at the direction of the A/E or authority having jurisdiction.

2.7 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.
- B. T8 instant-start low-mercury lamps, rated 32 W maximum, 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- C. T8 instart-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches 610 mm, 1300 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- D. Compact Fluorescent Lamps: CRI 80 (minimum), color temperature 3500, average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.
 1. T4, Twin Tube: Rated 5 W, 250 initial lumens (minimum).
 2. T4, Twin Tube: Rated 7 W, 400 initial lumens (minimum).
 3. T4, Twin Tube: Rated 9 W, 600 initial lumens (minimum).
 4. T4, Twin Tube: Rated 13 W, 825 initial lumens (minimum).
 5. T4, Double-Twin Tube: Rated 13 W, 900 initial lumens (minimum).
 6. T4, Double-Twin Tube: Rated 18 W, 1200 initial lumens (minimum).
 7. T4, Double-Twin Tube: Rated 26 W, 1800 initial lumens (minimum).

2.8 HIGH-INTENSITY-DISCHARGE LAMPS

- A. High-Pressure-Sodium Lamps: NEMA C78.42, wattage and burning position as scheduled, CRI 21 (minimum), color temperature 1900, and average rated life of 24,000 hours.
- B. Low-Pressure-Sodium Lamps: NEMA C78.41.
- C. Metal-Halide Lamps: ANSI C78.1372, wattage and burning position as scheduled, CRI 65 (minimum), and color temperature 4000.

2.9 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 16 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage.
- E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.10 FINISHES

- A. Fixtures: Manufacturers' standard, unless otherwise indicated.
 - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 - 2. Metallic Finish: Corrosion resistant.

2.11 LIGHTING CONTROL DEVICES

- A. Dimming Ballast Controls: Sliding-handle type with on/off control; compatible with ballast and having light output and energy input over the full dimming range.
- B. Light Level Sensor: Detect changes in ambient lighting level and provide dimming range of 20 to 100 percent in response to change.
 - 1. Sensor Capacity: At least 40 electronic dimming ballasts.
 - 2. Adjustable Ambient Detection Range: 10 to 100 fc minimum.
- C. Occupancy Sensors: Adjustable sensitivity and off delay time range of 5 to 15 minutes.
 - 1. Device Color:
 - a) Wall Mounted: Ivory.

- b) Ceiling Mounted: White.
- 2. Occupancy detection indicator.
- 3. Ultrasonic Sensors: Crystal controlled with circuitry that causes no detection interference between adjacent sensors.
- 4. Infrared Sensors: With daylight filter and lens to afford coverage applicable to space to be controlled.
- 5. Combination Sensors (Dual Technology): Ultrasonic and infrared sensors combined.

2.12 SOURCE QUALITY CONTROL

- A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.
- B. Factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
 - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Fixture Support: As follows:
 - 1. Pendants and Rods: Where longer than 48 inches, 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. Continuous Rows: Suspend from cable.

- D. Air-Handling Fixtures: Install with dampers closed and ready for adjustment.
- E. Adjust aimable fixtures to provide required light intensities.

3.2 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Verify normal operation of each fixture after installation.
- C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.
- D. 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.
- E. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.
- F. Field adjustments to sensors after occupancy.

END OF SECTION 16511

1.12. Section 16670 - Lightning Protection

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 lightning protection for buildings, building elements, and building site components. The lightning protection system for the project shall be provided on a design build basis by a certified LPI Master Installer/Designer.

1.3 SUBMITTALS

- A. Product Data: For air terminals and mounting accessories.
- B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.
- C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association.
- D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the roofing material.
- E. Field inspection reports indicating compliance with specified requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is NRTL listed or who is certified by LPI as a Master Installer/Designer.
- B. Listing and Labeling: As defined in NFPA 780, Article 2-2, "Definitions."
- C. Provide UL Master Label.

- D. Provide LPI certification of system.
- E. Provide ETL Master Label indicating system complies with specified requirements.

1.5 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and installer.

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:

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96.
- B. Roof-Mounting Air Terminals: NFPA Class II, copper, solid, unless otherwise indicated.
 - 1. Roof-Mounting Air Terminals: Designed for roof materials.
- C. Flag pole and tower-Mounting Air Terminals: Solid copper.
- D. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 16 Section "Grounding and Bonding" and standards referenced in this Section.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A, LPI-175, and NFPA 780 whichever is the most stringent or comprehensive requirements per application.

- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- C. Conceal the following conductors:
 - 1. Down conductors.
 - 2. Interior conductors.
 - 3. Conductors within normal view from exterior locations at grade within 200 feet of building.
 - 4. Notify Owner at least 48 hours in advance of inspection before concealing lightning protection components.
- D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.
- E. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- F. A counterpoise installation based on requirements in Division 16 Section "Grounding and Bonding" may be used as a ground loop required by NFPA 780, provided counterpoise conductor meets or exceeds minimum requirements in NFPA 780.
 - 1. Bond ground terminals to counterpoise conductor.
 - 2. Bond grounded metal bodies on building within 12 feet of ground to counterpoise conductor.
 - 3. Bond grounded metal bodies on building within 12 feet of roof to counterpoise conductor.
- G. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

- A. Periodic Inspections: Engage an LPI inspector to perform periodic inspections during construction and at its completion, according to LPI-177.

- B. UL Inspection: Apply for inspection by UL as required to obtain a UL Master Label for system.

END OF SECTION 16670

1.13. Section 16726 - Public Address (P.A.) Equipment

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes equipment for amplifying, distributing, and reproducing sound signals.

1.3 DEFINITIONS

- A. Channel: Separate signal path, from source to loudspeaker.
- B. VU: Volume unit.

1.4 PERFORMANCE REQUIREMENTS

- A. System Functions: Include the following:
 - 1. Communicating simultaneously to all zones regardless of zone or channel switch settings.
 - 2. Paging, from microphone.
 - 3. Reproducing high-quality sound that is free from noise and distortion at the loud-speaker.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection.
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components.
- C. Calculations: For sizing backup battery.
- D. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.

- E. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
- F. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.
- G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- H. Maintenance Data: For equipment to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section.
- 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.
- C. Comply with NFPA 70.
- D. Comply with UL 50.

1.6 OCCUPANCY ADJUSTMENTS

- A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions. Provide up to three on-site assistance visits within one year of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alpha Communications.
 - 2. Altec Lansing/University Sound.
 - 3. Atlas-Soundolier; Atapco Security & Communications Group.
 - 4. Bogen Communications, Inc.
 - 5. Dukane Corp.; Communications Systems Div.

6. Electro-Voice, Inc.
7. Executone Information Systems Inc.
8. Federal Signal Corp.; Signal Div./Electrical Products.
9. Peavey Electronics Corp.
10. Rauland-Borg Corp.
11. Whelen Engineering Co., Inc.

2.2 EQUIPMENT

- A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Modular type, using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- C. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.

2.3 POWER AMPLIFIERS

- A. Comply with EIA SE-101-A.
- B. Mounting: Counter top
- C. Output Power: 70-W balanced line.
- D. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
- E. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
- F. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
- G. Output Regulation: Less than 2 dB from full to no load.
- H. Controls: On/off, input levels, and low-cut filter.
- I. Input Sensitivity: Matched to preamplifier and providing full-rated output with a sound-pressure level of less than 10 dynes/sq. cm impinging on a speaker microphone or handset transmitter.

2.4 COMPONENTS

- A. Microphone: Comply with EIA SE-105.
 1. Type: Dynamic, with cardioid polar or omnidirectional characteristic.

2. Impedance: 150 ohms.
 3. Frequency Response: Uniform, 60 to 12,000 Hz.
 4. Output Level: Minus 58 dB minimum.
 5. Finish: Satin chrome.
 6. Mounting: Desk stand with integral-locking, press-to-talk switch.
- B. Horn-Type Loudspeakers: Comply with EIA SE-103.
1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
 2. Matching Transformer: Comply with EIA-160. Full-power rated with four EIA standard taps. Maximum insertion loss of 0.5 dB.
 3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
 4. Dispersion Angle: 130 by 110 degrees.
 5. Mounting: Integral bracket.
 6. Units in Hazardous (Classified) Locations: Listed and labeled for the environment in which they are located.
- C. Cable and Conductors: Jacketed, twisted-pair and twisted-multipair, untinned, solid-copper conductors.
1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
 2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick over shield with filled interstices. Shield No. 34 AWG tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
 3. Plenum Cable: Listed and labeled for plenum installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment to comply with manufacturer's written instructions.
- B. Wiring Method: Install wiring in raceway except within consoles, desks, and counters. Conceal cable and raceway except in unfinished spaces.
- C. Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum-board partitions where cable-wiring method may be used. Use plenum cable in environmental air spaces, including plenum ceilings. Conceal cable and raceway except in unfinished spaces.
- D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) for speaker microphones and adjacent parallel power and telephone wiring. Separate other

intercommunication equipment conductors as recommended by equipment manufacturer.

- E. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- F. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- G. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.
- H. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
- I. Weatherproof Equipment: Install units that are mounted outdoors, in damp locations, or where exposed to weather consistent with requirements of weatherproof rating.

3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
- C. Install grounding electrodes as specified in Division 16 Section "Grounding."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installations, including connections. Report results in writing.
- B. Operational Test: Perform tests that include originating program and page material at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and freedom from noise and distortion.
- C. Signal-to-Noise Ratio Test: Measure the ratio of signal to noise of complete system at normal gain settings, using the following procedure:

1. Disconnect a microphone at the connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other micro-phones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure the ratio of signal to noise.
 2. Repeat test for each separately controlled zone of loudspeakers.
 3. Minimum acceptance ratio is 50 dB.
- D. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Division 16 Section "Grounding."
- E. Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare written record tests.
- F. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
- G. Schedule tests with at least seven days' advance notice of test performance.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment as specified below:
1. Train Owners maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment.
 2. Review data in maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data/Owner Training."
 3. Schedule training with Owner, through Supervising Professional, with at least seven days' advance notice.

END OF SECTION 16726

1.14. Building Telecommunications

1.14.1. Section 16741 – Communications Cable & Equipment

PART 1 - GENERAL

SCOPE

This section describes the products and execution requirements relating to furnishing and installation of Telecommunications Cabling and Termination Components and related sub-systems as part of a Structured Cabling System at the [new or remodeled] [building and location]. Inter-building, Vertical (Backbone), and Horizontal (Station) cabling comprised of Copper, Fiber Optic, and Coaxial Cabling are covered under this document. Included are the following topics:

PART 1 - GENERAL

- Scope
- Related Work
- Regulatory References
- Design Intent
- Work Sequence
- Submittals
- Project Record Documents
- Quality Assurance
- Delivery, Storage and Handling
- Drawings

PART 2 - PRODUCTS

- Lightning Protection
- Backbone (Riser & Tie) Copper Cabling
- Backbone Voice Cabling
- Shielded Cabling (T1)
- Horizontal Media (Station Cables)
 - Horizontal Data and Voice Station Cable (Copper)
 - Horizontal Fiber Optic Station Cable
- Coaxial Cable (Video-RF)
- Video Distribution Line Amplifier
- Coaxial Cable Splitters
- Information Outlet
 - Data and Voice Jacks
 - Wall-Mount Voice-Only Outlets
 - F-Connector (RG-6 Coax)
- Data Patch Panel
- Voice (Horizontal) Termination Field

- Coax Patch Panel
- Equipment Rack
 - Jumper Management
- Equipment Cabinets (Wall Mount)
- Flexible Nonmetallic Innerduct and Fittings
- Miscellaneous Materials
 - Voice & Data Station Patch Cords
 - Power Strip/Surge Suppressor
- Surface Raceway
- Telecommunications Ground

PART 3 - EXECUTION

- General
- System Topology and Cable Size Requirements
 - T1 Cabling
 - Station Cabling
 - Station Cabling on Modular Furniture
 - Information Outlet
- Innerduct
- Cable Termination
 - General
 - Cable Termination - Voice UTP
 - Voice Multiplier Blocks
 - Cable Termination - Data UTP
 - Cable Termination - Shielded (T1)
 - Cable Termination RG-6 Coax
 - Voice Cross Connects
 - Equipment Rack (Free Standing)
 - Identification and Labeling
 - Work by Owner
 - Cooperation
- Testing and Acceptance
 - General
 - Voice Cabling (Copper UTP)
 - Voice Station Cabling (Category 6)
 - Data Station Cabling (Category 6)
 - Category 6 Performance Testing
 - Fiber Optic Cable
 - RG-6 – Testing
 - Shielded Cabling (T1) – Testing
- Documentation
 - General
 - Test Data - Copper Media
 - Test Data - Fiber Optic Media

Cross Connect Data
As-Built Construction Drawings
Warranty
As-Built Communication Cable Costs

1.14.2. As-Built Communication Cable Costs

RELATED WORK

Applicable provisions of Division 16 govern work under this Section.

Section 16130 – Raceways and Boxes

Section 16140 – Wiring Devices

Section 16060 – Grounding and Bonding

Section 16075 – Electrical Identification

REGULATORY REFERENCES

All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Wisconsin Electrical Code and present manufacturing standards.

All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

Other applicable standards are as follows:

ANSI/IEEE C2 - National Electrical Safety Code

NFPA 70- 2002 - National Electrical Code

DILHR Chapter 16 - Wisconsin Electrical Code

TIA/EIA Standards 526-14A (OFSPT-14A), 526-7 (OFSPT-7), 568B.1 (Category 5e), 568B.2 (Category 6), 568B.3, 569A, 606A, and 607 (with exception)

IEEE/ANSI 142-1982 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

ICEA publication S-80-576-2002

DESIGN INTENT

The Horizontal (Station) Cabling System is based on the installation of 4-Pair Unshielded Twisted Pair (UTP) DATA [Category 5e][Category 6] and 4-Pair UTP VOICE [Category 5e][Category 6] Copper Cables. The cables shall be installed from the Standard Information Outlet (SIO) in the work area to the Telecommunications Room (TR) or Equipment Room (ER) serving that area and terminated as specified in this document.

Station cables shall be installed in conduit, in cable tray and in modular furniture. Outlets shall be mounted flush on a wall-mounted box, on Surface Raceway and in Modular Furniture. Information Outlet locations are to be identified on Project Drawings.

Backbone Copper and Fiber Optic Cables (linking Equipment Rooms and/or Telecommunications Rooms) shall be installed in conduit in building riser pathways, in cable tray and/or free-air in as identified on the Drawings. Backbone Intra-building Fiber Optic Cabling shall be installed via Conduit and/or Cable Tray.

At the Main Equipment Room (Room No. 104) Data, Fiber Optic and Coaxial cable terminations shall be mounted on freestanding equipment racks; termination hardware related to Voice Cabling shall be wall mounted.

All cables and related termination, support and grounding hardware, bonding, shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following section[s].

The Contractor shall provide all labor and materials necessary to construct the system as described herein. This includes - but is not limited to - furnishing and installing cable, cable supports, innerduct, racking and termination components, termination, testing, labeling and documentation.

WORK SEQUENCE

During the construction period, coordinate telecommunications schedule and operations with the State of Wisconsin, Division of State Facilities Construction Representative and Owner.

SUBMITTALS

Under the provisions of Division 1, prior to the start of work the Contractor shall submit:

1. Six (6) sets of Manufacturer's Data covering all products proposed indicating construction, materials, ratings and all other parameters identified in Part 2 (Products) below.
2. Manufacturer's installation instructions, and
3. One (1) two-foot section of each cable type to be utilized for final approval by the Engineer. This two-foot section shall have the manufacturer's cable markings visible. Upon request, samples from every reel sent to the site shall be provided.

Submittals should be grouped to include complete documentation of related systems, products and accessories in a single submittal. Where applicable, dimensions should be marked in units to match those specified.

Submittals shall be original catalog sheets, photocopies, or electronic format (ADOBE Portable Document format ".pdf") thereof. Facsimile (fax) sheets shall not be accepted.

Two sets of submittals. The Engineer shall review the Submittals and annotate them indicating approvals and shall return to the contractor.

Work shall not proceed without the Engineer's approval of the submitted items.

If materials are furnished as specified no further qualifications is necessary, except for items requiring shop drawings. However, if the Contractor wishes to substitute another manufacturer and/or catalog number, the following information in triplicate shall be submitted to the Engineer:

A complete description of the material which the contractor proposes to substitute (shop drawings, illustrations, catalog data, performance characteristics, etc.) and the reason for the substitution identifying any benefit to the Owner.

The Contractor shall receive approval from the Engineer on all substitutions of material. No substituted materials shall be installed except by written approval from the Engineer.

PROJECT RECORD DOCUMENTS

Submit and record documents under provisions of Division 1.

Accurately record exact sizes, locations and quantities of cables.

QUALITY ASSURANCE

The manufacturer shall be a company specializing in communication cable and/or accessories with a minimum of five years documented experience in producing cable and/or accessories similar to those specified below.

The contractor shall have been in this line of business for a minimum of five (5) years and completed four (4) jobs of the magnitude specified in the following sections.

The installing contractor shall have at a minimum one (1) Certified Installer trained to the latest industry standards to ensure the most reliable installation available. The Certified Installer shall have been trained by a company(s) that offers a minimum fifteen (15) year system warranty.

DELIVERY, STORAGE AND HANDLING

Cable shall be stored according to manufacturer's recommendations as minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 4 degrees C, the cable shall be moved to a heated (10 degrees C minimum) location.

If the contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner. If necessary, cable shall be stored off site at the contractor's expense.

DRAWINGS

It shall be understood that the electrical and telecommunication details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the Contractor in bidding the job. The Contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.

The Contractor shall verify all dimensions at the site and be responsible for their accuracy.

Prior to submitting the bid, the Contractor shall call the attention of the Engineer to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted, within ten (10) days prior to the Bid Due Date.

PART 2 - PRODUCTS

BACKBONE COPPER DATA CABLING

Backbone Copper Data Cables shall meet all of the specifications detailed above for "Horizontal Data Station Cables " plus the following:

Cable shall conform to TIA/EIA-568-B "Power Sum Crosstalk" standards with the requirement that the sum of multi-pair Crosstalk be no worse than the pair-to-pair Crosstalk of a 4-pair cable.

Link performance of any combination of up to six (6) 25-pair and/or 4-pair cable segments totaling 90-meters in length or less shall be compliant with TIA/EIA-568-B requirements.

Color-coding of the pairs shall be per industry standards for 25-pair cables.

This cable shall be suitable for installation free-air, in building Risers, in Conduit and/or in Cable Tray and carry a CMP rating.

SHIELDED CABLING (T1)

Cabling installed to accommodate T1 transmission (1.544-Mbps) shall incorporate a minimum of two (2) twisted pairs. Where multiple circuits are required, higher pair-count cabling may be used.

Conductors shall be 22 AWG, solid bare copper. Each pair shall be individually shielded and incorporate a drain wire.

Cable shall meet Category 6 performance specification.

Cable shall be UL listed and meet a CMP rating.

HORIZONTAL MEDIA (STATION CABLES)

General

The Horizontal (Station) Cable System is based on the installation of Un-shielded Twisted Pair (UTP) DATA Category 6 and VOICE (Telephone) Category 6 copper cables to install from the work area to the wiring hub locations(s). Refer to the Floor plan Drawings(s) which identify the location of the wiring hubs and Standard Information Outlets (SIO) locations.

Voice and Data Station Cables shall be constructed of individually twisted pairs with 24-AWG insulated solid copper conductors.

All Cables and Termination hardware shall be technically compliant with and installed in accordance with the referenced TIA/EIA documents.

All cables shall be suitable for installation in the environment defined and shall meet a CMP] rating (or approved substitutes as defined by the 2002 NEC).

Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code and shall meet the specifications of NEMA (low loss), UL 444, and ICEA.

Pairs of all 4-pair cables shall be unshielded and shall be identified by a banded color code in which conductor insulation is marked with a dominant color and banded with a contrasting color. By pair number, the pair colors or dominant band are:

- Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White)
- Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White)
- Pair 3: Tip - White/Green; Ring - Green (or Green/White)
- Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White)

Horizontal Data and Voice Station Cable (Copper)

All horizontal Data Station Cables shall terminate on modular Patch Panels in their respective Telecommunications Rooms (TR) or Equipment Room (ER) as specified on the drawings.

All horizontal Voice Station Cables shall terminate on modular Category 6 Patch Panels or Category 6 110 blocks in their respective Telecommunications Rooms (TR) or Equipment Room (ER) as specified on the drawings.

All cables, termination components and support hardware shall be furnished, tested, installed and wired by the Contractor.

Transmission characteristics of the Data and Voice Station Cables shall meet full Category 6 performance criteria as defined by the referenced TIA/EIA documents. Refer to the Execution Section which details the required performance criteria of the completed Link of which the Cable is a part.

IMPORTANT: Cable and Termination Components (Jack, Patch Panel, Wiring Blocks) are specified to function as a System. The compatibility of the Cable to be installed with the proposed termination components shall be recognized and documented by the Termination Component Manufacturer.

The jacket color for Data cables shall be blue.

The jacket color for Voice cables shall be white.

Cable shall be packaged in a way that minimizes tangling and kinking of the cable during installation. Examples are open reels or packages that incorporate a rotating reel.

COAXIAL CABLE (VIDEO-RF)

The telecommunications contractor shall install the coaxial cables including video trunk cables, connectors, splitters, and line amplifiers as contracted, and as shown on the Drawings. Refer to Execution Section of this document.

Inside Cable

The inside vertical riser cable shall be a .500 trunk distribution type cable, with solid aluminum jacket.

The horizontal cable runs shall be RG-6.

Outside Plant Cable

Outside plant cable shall be a Type .500. This cable shall incorporate a flooding compound and be suitable for trunk distribution.

VIDEO DISTRIBUTION LINE AMPLIFIER

This contractor shall provide all Video Line Amplifiers. All video distribution line amplifiers shall support a video bandwidth of 750 MHz or higher. Line Amplifiers shall be equipped to include "plug-in" equalization variable slope and gain controls, and built-in duplex filters for standard sub-channel two-way operation with active return, which will support two-way interactive services.

COAXIAL CABLE SPLITTERS

This contractor shall provide all hard-line coaxial splitters to provide adequate distribution of all horizontal coaxial cable in each IDF and MDF. All splitters shall support a video bandwidth of 1 GHz.

"TV" Coax (RG-6)/

Cable shall be listed as being suitable for use in environment defined and shall meet a CMP rating (or better as defined by the 2002 NEC).

Basic Construction:

- Center conductor - 18 AWG Copper Covered Steel; 0.040" O.D. (nominal); foamed polyethylene dielectric
- Inner shield - aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric
- Second shield - 60% 34 AWG bare aluminum braid wire
- Third shield - non-bonded aluminum foil tape
- Outer shield - 42% 34 AWG bare aluminum braid wire
- Outer Jacket - Flame-retardant PVC
- Impedance 75-Ohms
- Capacitance 16.0 pF/ft (nominal)
- Velocity of propagation 84.0%

1.14.3. Information Outlet

Station cables shall each be terminated at their designated workstation location in the connector types described in the sub-sections below. Included are modular jacks (Voice & Data), Fiber Optic Connectors and Coaxial Connector assemblies. These connector assemblies shall snap into a mounting frame and exit flush. All ports shall be installed such that the opening faces the floor. The combined assembly is referred to as the Standard Information Outlet (SIO).

SIO mounting configurations shall be as follows:

- Flush where existing boxes are in place
- Surface mounted on Systems Furniture (base panel) - Systems Furniture Type shall be defined prior to construction.
- All data/voice jacks shall be flush.

The Telecommunications Outlet Frame shall accommodate:

1. a minimum of four (4) Modular Jacks, Fiber Optic Connectors and/or Coaxial Connectors when installed on a wall-mounted assembly.
2. a minimum of four (4) Modular Jacks, Fiber Optic Connectors and/or Coaxial Connectors when installed on a Floor-mounted assembly.
3. a minimum of two (2) Modular Jacks and/or Coaxial Connectors when installed on modular furniture.
4. the outlet frame shall incorporate a mechanism for adjusting the surface plate to a plumb position.

Multiple Jacks - identified in close proximity on the drawings (and not separated by a physical barrier) - may be combined in a single assembly. The contractor shall be responsible for determining the optimum compliant configuration based on the products proposed and documenting these in the as-built records.

The same orientation and positioning of Jacks and Connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each SIO type for review by the Engineer.

Wall Mount Outlet Faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

Where stand-alone "Data" or "Voice" only Jacks are identified, the SIO Frame shall be configured as to allow for the addition of one (1) additional jack (Voice or Data) to be installed to supplement each such jack as defined by this project. The installation of these supplemental Jacks IS NOT part of this project.

Any unused jack positions shall be fitted with a removable blank inserted into the opening.

All Jacks and Connectors will be fitted with a dust cover. Modular Jacks shall incorporate a dust cover that fits over and/or into the jack opening. The dust cover shall be designed to remain with

the jack assembly when the jack is in use. No damage to the Jack pinning shall result from insertion or removal of these covers. Dust covers, which result in deformation of the jack pinning, shall not be accepted.

The faceplate of the SIO shall be constructed of High Impact Plastic. Faceplate color shall (1) match the faceplate color used for other utilities in the building or (2) when installed in Surface Raceway (if applicable), match the color of the Raceway.

Different frame designs for locations which include fiber optic cabling verses those which terminate only Copper Cabling (UTP and/or Coax) are acceptable. Outlets which incorporate optical fiber shall be compliant with the above requirements plus:

1. Be a low-profile assembly,
2. Incorporate a mechanism for storage of cable and fiber slack needed for termination,
3. Position the fiber optic couplings to face downward or at a downward angle to prevent contamination and,
4. Incorporate a shroud that protects the optical couplings from impact damage.

Wall-mounted "Voice Only" outlets shall be installed where identified on the Floorplan Drawings to accommodate wall-mounted telephone sets. The Wall Plate shall be of Stainless Steel construction, accommodate one (1) voice jack as defined below, mount on a standard single gang outlet box or bracket and include mating lugs for wall phone mounting.

All Standard Information Outlets and the associated Jacks shall be of the same manufacturer throughout the project. An allowable exception, however, is the Wall-mounted "Voice Only" Outlet described above.

Data and Voice Jacks

Data and Voice jacks shall be an 8-pin Modular Jack.

The interface between the jack and the station cable shall be a 110-Style block or insulation displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination

Data Jacks shall be pinned TIA-568A with the pairs as follows:

Voice Jacks shall be pinned TIA-568A with the pairs as follows:

TIA-568A: Pair 1 – Pins 5 & 4
 Pair 2 - Pins 3 & 6
 Pair 3 - Pins 1 & 2
 Pair 4 - Pins 7 & 8

Transmission characteristics of the Data and Voice Jack shall be as required to meet the TIA/EIA Category 6 performance criteria. Refer to the Execution Section which details the required performance criteria of the completed Link of which the Jacks are a part.

The Jack shall be UL verified and listed.

Jack contacts shall have a minimum of 50 micro-inches of gold plating.

The color of the Data Jack shall be **Orange** where used for another application a color unique from the data and voice jack shall be used. Alternately, a color-coded Bezel or Icon may be used to identify the Data and Voice Jack.

The Color of the Voice Jack shall be **Black**.

Wall-mount Voice-Only Outlets

Wall mounted "voice only" outlets shall be installed where identified ("W") on the Project Drawing(s) to accommodate wall-mounted telephone sets. The Wall Plate shall be of Stainless Steel construction, accommodate one (1) voice jack as previously defined, mounted on a standard single gang outlet box or bracket and include mating lugs for wall phone mounting.

F-Connector (RG-6 Coax)

RG-6 Coax cable shall be terminated at the Workstation and at the Telecommunications Rooms in a Male "F" type connector.

The Male F-Connector shall:

1. be matched to the RG-6 cable type proposed by the Contractor ,
2. be a single piece connector,
3. incorporate a ½-inch crimp ring which uses hex or compression crimp

When preparing the RG-6 cable for termination, manufacturer installation procedures shall be adhered to. Special care shall be taken to insure the proper center conductor length as specified by the manufacturer.

The Male F Connectors shall be mated to Female/Female Feed-thru Couplings at both the Outlet and Patch Panel locations. These couplings shall be matched to the Male F connector type. Couplings shall be of sufficient length as to allow for the Male F-Connector to fully seat (both sides).

IMPORTANT: It is the responsibility of the Contractor to ensure that their proposed design considers the available mounting depth in both the existing wall boxes and possible Surface Raceway. This may include the provision of Right Angle Cable Plugs, Feed through Couplings or other means.

DATA PATCH PANEL

Data cabling shall be terminated at the Telecommunications Room #104 on panels incorporating

Modular Jacks meeting the specifications for the Telecommunications Outlet detailed in the Section above.

At the Telecommunications Room, these panels shall be rack mounted

The Data Patch Panel shall consist of a Modular to 110-type connector system. Modular jacks shall meet the specifications detailed above (NON-KEYED 8-pin). On the Wall-mounted panels, this interface shall be on the front of the panel (same size as modular jacks) and be protected by a cover plate when in use.

Wall-mounted patch panels shall incorporate a standoff bracket to allow for cabling to be routed behind the panel.

The largest single patch panel configuration shall not exceed 72 ports. Panels which are modular shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12-jacks. High density patch panel configurations must incorporate horizontal cable management systems sized to accommodate the quantity of patch panel jacks being installed.

The Patch Panel blocks shall have the ability to seat and cut 8 conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Data blocks shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.

The Data Patch Panel as a system (including jack, cable interface and intermediate components) must maintain Category 6 performance per the referenced TIA/EIA documents. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.

Panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to insure that all manufacturers minimum bend radius specifications are adhered to.

The Patch Panel shall have color-coded designation strips to identify cable count.

Transmission performance shall be maintained by the Data Patch Panel as a system (including jack, cable interface and intermediate components).

VOICE (HORIZONTAL) TERMINATION FIELD

At the Telecommunication Room(s) and Main Equipment Room, each Horizontal Voice Cable shall be terminated on high density 110 blocks. Wall mounted patch panels and terminal blocks must be mounted on a prepared surface consisting of 5/8-inch plywood securely fastened to the building walls. All six surfaces of the plywood must be painted with fire retardant paint.

Each horizontal row shall be cable of terminating six (6) four pair groups (Station Cable).

Blocks shall identify pair position by color designation.

The blocks shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.

The voice termination field (blocks) must maintain Category 6 performance per the referenced EIA/TIA documents. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.

Each row of blocks shall be provided with a label holder which is to be used to identify the cable pairs.

The Voice Termination Hardware shall be 110-style.

- Voice Horizontal Cabling Termination
- Four (4) Pair Termination Clips (e.g. C4) shall be used in the termination of Voice Station Cabling

Horizontal Troughs incorporating plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block.

Vertical Troughs incorporating plastic distributing rings shall be provided in the Entrance Room for vertical routing of jumper and/or cross-connect wire. In each telecommunication room, a backboard incorporating plastic distribution rings allowing for a change in direction in cross connect wiring shall be installed between the blocks on which station cabling is terminated.

VOICE BACKBONE TERMINATION FIELD

At the Telecommunications Room(s) and Main Equipment Room, each Voice "Backbone" Cable shall be terminated on high-density horizontal 110 blocks. Wall mounted terminal blocks must be mounted on a prepared surface consisting of 5/8-inch plywood securely fastened to the building walls. All six surfaces of the plywood must be painted with fire retardant paint.

Each horizontal row of the cross-connect block must be capable of terminating one (1) twenty-five pair binder group (Backbone Cables). Backbone blocks shall be segregated clearly identifying their function.

The mechanical termination shall:

1. have the ability of terminating 22 - 26 AWG plastic insulated, solid and stranded copper conductors.
2. provide a direct connection between the cable and jumper wires.
3. have less than 0.2-dB of attenuation from 1 - 16 MHz.
4. have less than 100 milli-Ohm of DC resistance.
5. have less than 5 milli-Ohm of resistance imbalance.
6. have minimal signal impairments at all frequencies up to 16 MHz.

Blocks shall identify pair position by a color designation - Blue, Orange, Green, Brown and Slate (Backbone only)

The blocks shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.

The Voice Termination Hardware shall be 110-style.

- Voice Backbone Cabling Termination
- Five (5) Pair Termination Clips (e.g. C5) shall be used in the termination of Voice Backbone Cabling

Horizontal Troughs incorporating plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block.

Vertical Troughs incorporating metal distributing rings shall be provided in the Entrance Room for vertical routing of jumper and/or cross-connect wire. In each telecommunication room, a backboard incorporating plastic distribution rings allowing for a change in direction in cross connect wiring shall be installed between the blocks on which station and backbone cabling are terminated.

COAX PATCH PANEL

All terminated coaxial cables shall be mated to Female/Female "F" Series Couplings mounted on a panel.

The panels shall incorporate a dielectric (e.g. polycarbonate) insert on which the couplings are mounted to provide electrical isolation of connection points.

The panels shall incorporate cable management brackets at the rear of the panel on which to secure the RG-6 cables.

EQUIPMENT RACK

Free Standing Equipment Rack

At the Telecommunications Room, Equipment Racks shall be furnished and installed by the contractor to house Cable Termination components (e.g. Copper Data and Fiber Optic) and Network Electronics (by others). Refer to Part 3 ("Execution") of this Section for quantities required at each location. Where additional Equipment Racks are required or where existing racks are in place and none are required, it shall be so noted on the Floorplan Drawings.

The rack shall conform to the following requirements:

1. The rack shall comply with State Building Codes for the seismic area in which it is to be installed.
2. Rack shall be 84-inches in height and shall be self-supporting.
3. Channel uprights shall be spaced to accommodate Industry standard 19" mounting.

4. Rack must be constructed of aluminum and have either a coating or painted surface.
5. Rack shall be double-side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per EIA/TIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3-inch intervals to accept cable brackets
6. Rack should be supplied with a supply of spare screws (minimum of 24).
7. Base footprint should be no smaller than 15"x20".
8. Rack should be supplied with a ground bar and #6 AWG Ground lug.

Jumper Management

Rack shall be equipped with Vertical and Horizontal Jumper Management Hardware in the form of rings and guides, as to allow an orderly routing of twisted pair, optical fiber and coaxial jumpers from the patch panels to the customer provided network equipment. Jumper management hardware shall be as follows:

Horizontal Jumper Management Panels shall be plastic (3.5-inch panel), have a minimum of five (5) Jumper distribution rings (1.75" x 3.75" minimum dimension).

At minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of Jacks Data Patch Panels, (b) each grouping of two rows of "F" connectors on Coaxial Patch Panels and (c) above and below each Fiber Optic Patch Panel.

Vertical jumper management shall provide for cable routing on front and rear of each rack and be 3½" square (minimum). Vertical Jumper Management hardware shall mount on spacers attached to the rack uprights and not on the upright itself. Where multiple racks are to be installed, this hardware shall be mounted between the uprights of adjacent racks. Rack uprights and the spacers shall be secured together per manufacturer recommendations.

Each rack shall be supplied with a minimum of twelve (12) releasable (e.g. "hook & loop") cable support ties.

NOTE: Where Cable Termination Hardware is wall mounted, the contractor shall be responsible for establishing a cable pathway for jumpers routed from the Equipment Rack(s) to the wall. This shall be in the form of slotted ducts, troughs, "D" rings or other means. Routing of jumpers via the overhead ladder rack system is not acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Engineer prior to installation.

FLEXIBLE NONMETALLIC INNERDUCT AND FITTINGS

General

Flexible Non-metallic Innerduct (e.g. "Innerduct") may be used as follows:

1. to segment conduit(s), increasing their capacity,
2. as protection to backbone fiber optic cables when installed in cable tray, and
3. as protection to fiber optic cable(s) within equipment rooms and Telecommunications Rooms.

Innerduct shall be corrugated.

Where not installed in a continuous length, innerduct segments should be spliced using couplings designed for that purpose.

Any vacant innerduct shall be equipped with a pull cord and capped at all ends to inhibit the entry of water and contaminants.

Nominal duct size shall be 1-inch (minimum).

Innerduct should be rated (e.g. General, Flame-retardant, Riser or Plenum) as required by the installation environment. Riser and Plenum innerduct shall be of a color contrasting to that of the “Standard” and Flame-retardant innerduct. The preferred colors are Orange (“Standard & Flame-retardant”) and White (Riser and Plenum).

Flame-retardant Innerduct

Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all of the above General requirements plus:

1. Be fabricated of flame-retardant materials suitable for installation such environments, and
2. Meet or exceed all requirements for flame resistant duct as required by BELLCORE TR-NWT-000356 (Section 4.33).

Riser-rated Innerduct

Innerduct installed within building riser shafts shall meet all of the above General requirements plus:

1. Be fabricated of flame-retardant materials suitable for installation such environments, and
2. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

Plenum-rated Innerduct

Be fabricated of flame-retardant and smoke inhibiting materials suitable for installation in such environments, and

Meet or exceed all requirements for flame propagation and emissions as specified by test method UL-910 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in ducts, plenums and other areas for environmental air, and

Meet or exceed all requirements specified by the National Fire Protection Agency (NFPA) 90A and 262 for Plenum spaces. Testing for fire and smoke characteristics shall be per UL-910.

MISCELLANEOUS MATERIALS

Voice & Data Station Patch Cords

The contractor is to furnish station AND patch panel(s) patch cords for each SIO installed plus 20% for growth and consist of an 8P8C plug pinned 568A with Category 6 cable. Contact Tom Irwin, DSF, 608-266-2880 for specifications.

Power Strip / Surge Suppressor

At the Main Equipment Room and at each Telecommunications Room, one (1) Power Strip / Surge Suppressor shall be furnished and installed by the contractor to provide for powering of the network electronics (by others). Provide a quantity of two (2) twenty amp dedicated circuits mounted on the rack.

Power Strip / Surge Suppressor shall:

1. be rack mountable (19-inch rack)
2. be compliant with UL-1449, UL 1283 and UL-497A.
3. provide Transient suppression to 13,000-A. Protection shall be in all 3 modes (hot-neutral, hot-ground & neutral-ground).
4. shall meet or exceed IEEE 587 Category A & B specification.
5. provide High Frequency Noise Suppression as follows:
 - a. >20-dB @ 50-kHz
 - b. >40-dB @ 150-kHz
 - c. >80-dB @ 1-MHz
 - d. >30-dB @ 6- to 1000-MHz
6. provide a minimum of 320 Joules of AC Energy Absorption.
7. be equipped with a 12-foot power cord
8. provide a minimum of six (6) outlets

SURFACE RACEWAY

It is anticipated that Surface raceway will be used in this project.

In appropriate areas, Surface Raceway will be used as a cable path. No exposed wire shall be permitted.

With the agreement of the Architect/Engineer, if a need arises to add telecommunications outlets in areas where the walls cannot be fished, the station wire serving these outlets shall be covered

with raceways. No exposed wire shall be permitted within offices, laboratories, corridors, and conference rooms or like facilities.

The non-metallic surface raceway shall have a screw-applied base and have a snap on cover. Both the base and cover shall be manufactured of rigid natural PVC compounds.

The raceway shall originate from a surface mounted box located fourteen inches (14") off the floor and be attached to the wall and terminate above the ceiling. Raceway for a wall-mounted location shall originate from a surface mounted box located 48-inches off the floor.

The color of this raceway shall match the décor. All fittings including, but not limited to, extension boxes, elbows, tees, fixture boxes shall match the color of the raceway.

The raceway and all system devices must be UL Listed, exhibit nonflammable self-extinguishing characteristics, tested to specifications of UL94V-0 and be Category Compliant as defined by TIA/EIA 568B.

Refer to Electrical Section "Raceway and Boxes for Electrical Systems" for metallic and/or non-metallic Raceway guidelines for this Project. Minimum bend radius shall be adhered to for UTP and fiber optic cable.

TELECOMMUNICATIONS GROUND

At each Telecommunications Room, the Main Equipment Room and at the Electrical Service Entry, a "Telecommunications Grounding Busbar (TGB)" shall be installed by the Electrical Contractor. Refer to Section 16060 "Grounding and Bonding".

The telecommunication ground cable is to be an isolated grounding system pursuant to TIA/EIA 607 with the exception that the ground cable is not to be tied to building steel except at the electrical service entrance.

The contractor shall provide five (5) sets of the tool(s) required to operate the security screw type used on telecommunications outlet faceplates in secure areas. These tools shall be new and unused.

PART 3 - EXECUTION

GENERAL

Optical Fiber and Copper Pair counts of the cables to be supplied are detailed on the Project Drawings. Contractor shall furnish and install all cables, connectors and equipment as shown on drawings and as specified above. It shall be noted that all cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

Refer to Project Drawings which indicate the cable routes to follow and the termination location(s) within each building. Duct allocation shall be coordinated as part of the construction.

It is the contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified. This includes any modifications required to route and conceal horizontal distribution wiring.

Beginning installation means contractor accepts existing conditions.

Contractor shall furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not limited to, sheaves, winches, cable reels, cable reel jacks, duct entrance tunnels, pulling tension gauge and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices, which may move or wear in a manner to pose a hazard to the cable, shall not be used.

All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to insure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a "break-away" or other approved method.

The contractor will be responsible for identifying and reporting to the Site Coordinator(s) any existing damage to walls, flooring, tiles and furnishings in the work area prior to start of work. All damage to interior spaces caused by the installation of cable, raceway or other hardware must be repaired by the Contractor. Repairs must match preexisting color and finish of walls, floors and ceilings. Any contractor-damaged ceiling tiles are to be replaced by the contractor to match color, size, style and texture.

Where unacceptable conditions are found, the Contractor shall bring this to the attention of the construction supervisor immediately. A written resolution will follow to determine the appropriate action to be taken.

Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.

Cable pulling shall be done in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed. If any installed cable is kinked to a radius less than recommended dimension, it shall be replaced by the contractor with no additional cost to the project.

All wiring shall be run "free-air", in conduit, in a secured metal raceway or in modular furniture as designated on the floorplan(s). All cable shall be free of tension at both ends.

Avoid abrasion and other damage to cables during installation.

Pulling Lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.

The Cable system will be tested and documented upon completion of the installation as defined in the Section below.

A pull cord (nylon; 1/8-inch minimum) shall be co-installed with all cable installed in any conduit.

Should it be found by the Engineer, that the materials or any portion thereof, furnished and installed under this contract, fail to comply with the specifications and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

SYSTEM TOPOLOGY AND CABLE SIZE REQUIREMENTS

Backbone Cabling (Riser & Tie)

Backbone Cables shall be installed to link telecommunications rooms including:

Telecommunications Room #1 (TR#1; Room 104)

The following details the requirements relating to each cable type.

Voice Backbone Cabling

Backbone Voice cabling shall be sized based on the following minimum pair counts (The pair counts shall include 30% growth to the nearest cable size). Cabling is to be terminated on 110-type blocks. The contractor shall bond the outer metallic sheath of the cable to an approved ground using a #6 AWG solid copper wire. This shall be as close as practical to the Building Entrance ground as defined by applicable code.

Main Equipment Room - TR#1 Room104 NONE Required

Fiber Optic Backbone

Fiber Optic Backbone cabling shall be sized based on the following minimum fiber counts. Cabling is to be terminated on Patch Panels

Main Equipment Room - TR#1 Room 104 NONE Required

T1 Cabling

Shielded Cables (T1) shall be sized based on the following minimum counts. Cabling is to be terminated on 110-type blocks.

Main Equipment Room - TR#1 Room 104 (Capacity for 2 - T1 Circuits)

Station Cabling

Information Outlets cables with copper media (Voice & Data UTP and "TV" coax) shall be located as detailed on the Project Drawings.

The Bidder in determining materials quantities and routing should utilize these documents.

Station Cabling on each Floor shall be routed to the Telecommunications Room (TR) on that floor or to the designated TR if on another floor.

Station cables shall be run to the Information Outlet from the Telecommunications Room serving each area in conduit, free-air above drop ceiling, in cable tray and/or in modular furniture.

The maximum station cable drop length for Data and Voice UTP Category 6 shall not exceed 295-feet (90-meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing station cabling in a fashion as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Engineer prior to installation. All cables shall be installed splice-free unless otherwise specified.

During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.

Avoid abrasion and other damage to cables during installation.

All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellom grips may be used to spread the strain over a longer length of cable.

Where installed free-air, installation shall consider the following:

1. Cable shall run at right angles and be kept clear of other trades work.
2. Cables shall be supported according to code utilizing "J-" or "Bridal-type" mounting rings anchored to ceiling concrete, piping supports or structural steel beams. Rings shall be designed to maintain cables bend to larger than the minimum bend radius (typically 4 x cable diameter).
3. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.
4. Cable shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
5. Cables shall not be attached to existing cabling, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.

Manufacturer's minimum bend radius specifications shall be observed in all instances.

Care shall be taken in the use of cable ties to secure and anchor the station cabling. Ties shall not be over tightened as to compress the cable jacket. No sharp burrs shall remain where excess length of the cable tie has been cut.

Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.

A coil of 4 feet in each cable shall be placed in the ceiling at the last support (e.g. J-Hook, Bridal Ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each station cable under 250-feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

At all Telecommunication Rooms (TR), approximately 10-feet of slack shall be left in each station cable under 250-feet in length to allow for changes in the telecommunication room layout without re-cabling. These "service loops" shall be secured to the ladder rack, with "J" hooks, or "D" rings above the equipment, racks, and patch panels and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

To reduce or eliminate EMI, the following minimum separation distances from $\leq 480V$ Power lines shall be adhered to:

1. Twelve (12) inches from power lines of $<5\text{-kVa}$.
2. Eighteen (18) inches from high voltage lighting (including fluorescent).
3. Thirty-nine (39) inches from power lines of 5-kVa or greater.
4. Thirty-nine (39) inches from transformers and motors.

All openings shall be sleeved and firestopped per prevailing code requirements upon completion of cable installation.

IMPORTANT: Within the room in which Data Cabling is to be terminated, Hook and Loop (e.g. "Velcro") ties only shall be used from room entry to the point of termination. This is to facilitate the addition of future cables.

Station Cabling on Modular Furniture

Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via existing conduit.

Where modular furniture is installed without wall contact, the contractor shall install a "poke-thru" and route the station cabling via the floor below (but terminate at the TR on the floor on which the jack appears)]. The selection of the "poke-thru" shall consider fill ratios; bend limits on the Category 5e/6 UTP and the eventual feed into the furniture partition.

Cabling shall be protected in the transition from the "Poke-thru" or Wall Fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the "Poke-thru" and Wall Fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill Ratio (Cable Area vs. Conduit Area) in each feed shall not exceed 40%.

For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.

For purposes of bidding, it is to be assumed that it will be the responsibility of the Contractor to punch and re-install the bottom molding panels on the modular furniture as required to accommodate the Communications cabling and SIOs. The panels shall be marked prior to installation by the owner to identify the desired location of the SIOs. Any discrepancy between the Project Drawing identifying Outlet locations and the markings should be brought to the attention of the Site Coordinator(s).

The SIO shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the SIO to the panel shall not result in sharp protrusions (e.g. sheet metal screw tip) into the channel behind the panel.

Information Outlet

General

Information Outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on Surface Raceway and on modular furniture.

Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by the Site Coordinator and the Engineer. Nominal height (from finished floor to center line of Outlet) in new installation shall be as follows:

1.	Standard Voice & Data Outlet	18-inches
2.	Wall-Mounted Telephone Outlet (Standard Voice only)	54-inches.
3.	Wall-mounted Telephone Outlets for Wheelchair Persons:	
	Approach head on	per ADA regulations
	Approach parallel	per ADA regulations

INNERDUCT

Innerduct shall be riser or plenum rated as required by the installation environment. At minimum, innerduct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, innerduct segments should be spliced using couplings designed for that purpose.

All exposed innerduct is to be labeled at 35-foot (minimum) intervals with tags indicating ownership, the cable type (e.g. "Fiber Optic Cable") and the cables it contains.

Where required by the project design, fiber optic cable shall be installed in protective innerduct.

Contractor shall determine optimum size and quantity to satisfy the requirements of the installation insure that the mechanical limitations - including Minimum Bend Radius - of the cable are considered.

The innerduct should extend into the termination enclosure at system endpoints.

Where not installed in a continuous length, innerduct segments should be spliced using couplings designed for that purpose.

CABLE TERMINATION

General

At the Telecommunications Rooms, all Data and Voice Cables shall be positioned on termination hardware in sequence of the Outlet I.D. starting with the lowest number. Exceptions to the sequencing of terminations is allowed only with the permission of the DSF project manager and A/E.

Termination Hardware (Blocks and Patch Panels) Positioning and Layout must be reviewed and approved by the Engineer prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.

Cable Termination - Voice UTP

Voice pairs shall terminate on wall mounted 110-type blocks at the Telecommunications Room 104. The contractor shall coordinate the placement of blocks with the Engineer in order to integrate with other cabling.

Station Blocks shall be provided to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.

The contractor shall furnish and install cable management hardware (e.g. D Rings and cable guides) to neatly and securely route the cable from cable tray to the cable termination hardware.

The Height of the Voice Termination Field shall not exceed 6-feet (72-inches) above floor level to facilitate cable maintenance.

Blocks on which Backbone and Station Cabling are terminated shall be positioned in separate columns. Backbone Cabling should be positioned to the left; Station cabling to the right and be in close proximity as to simplify installation and subsequent tracing of cross-connect wiring. Where new cabling is to be integrated with existing cabling at the building entrance, it will be the responsibility of the Contractor, in cooperation with the Owner, to coordinate placement of Voice Termination hardware with the Local Exchange Carrier(s) serving the site.

Cables shall be fed from below the Termination Hardware in a manner that will facilitate growth.

Horizontal Troughs incorporating split plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block. Rings shall be positioned between the Backbone and Station blocks for vertical routing of jumpers and/or cross-connect wiring.

Termination of Horizontal Voice (Station) cabling shall be accomplished by using four-pair (e.g. C4-type) clips. The twenty-fifth pair of each row on the 110 type block located in the IDF shall not be used for termination of horizontal voice cable.

Termination of Backbone Voice cabling shall be accomplished by using five-pair (e.g. C5-type) clips.

The installer shall ensure that the twists in each cable pair are preserved to within 1.0-inch of the termination for all Voice UTP backbone cables and within 0.5-inch for Category 5e and Category 6 cables. The cable jacket shall be removed only to the extent required to make the termination.

A jumper wire spool holder shall be installed at the Main Equipment Room. Two full (1000-foot) spools of 24-AWG one-pair jumper wire, - green/white and orange/white - shall be supplied with the holder. The spool holders shall be assemblies designed for that purpose.

Voice Multiplier Blocks

At the MDF, Voice "Multiplier Blocks" shall be installed to accommodate the potential for multiple extensions of a single line. Each Multiplier Block shall be formed by running short sections of Cross-connect wire vertically through each index strip on a 100 pair block (4 rows). Five (5) Pair connecting clips shall be used. These multiple connections shall be clearly marked on the designation strips. Jumpers can then be wired (by others) from this common point to as many cable terminations as required.

One (1) each such 100 pair block shall be so configured at each telecommunication room.

Cable Termination - Data UTP

Data Patch Panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.

Data Patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.

At Information Outlets and Data Patch Panels, the installer shall insure that the twists in each cable pair are preserved to within 0.5-inch of the termination for Data cables. The cable jacket shall be removed only to the extent required to make the termination.

Cable Termination - Shielded (T1)

Shielded cabling shall be terminated on 110-type blocks. The blocks shall be wall-mounted at all locations.

Blocks shall be sized to provide for a minimum 20% growth in capacity relative to the initial installation.

Consistency shall be maintained throughout the installation relative to conductor sequence on the blocks. Building Ground and Cable Shield Drain Wire shall appear on the pair immediately to the left of each two data pairs on the cross-connect fields. Building ground connections are to be on the left of this pair (e.g. positions 1, 7, 13, etc.), with the cable shield at its adjacent right (e.g. positions 2, 8, 14, etc.). Cable shield shall be connected to the Telecommunications Ground via a short jumper on the connecting block(s) (e.g. 1 to 2, 13 to 14, etc.).

Designation labels shall be color-coded YELLOW to identify the cabling as a Network Connection. Pairs shall be identified on the labels numerically. Ground and Shield shall be identified for each pair.

Cable Termination RG-6 Coax

At the Telecommunications Room 104 the panels shall be rack mounted.

Panels shall be sized to accommodate an additional 20% growth in the number of cables terminated at any given location.

All cables shall be terminated in the specified connector type and mated to female feed-through couplers mounted on the panels. Coaxial cables shall be dressed neatly at the rear of the panel and secured to cable management brackets per manufacturer guidelines.

Voice Cross Connects

The contractor shall be responsible for the “Cross-connect” wiring between the Station (horizontal) and Backbone Voice cabling.

Four (4) pairs in each station cable shall be cross-connected to the Backbone (riser or tie) cable. 4-pair Cross-connect wire, color coded to identify each pair, shall be used. The 25TH pair position (50TH, 75TH, etc.) of each riser voice block shall remain vacant.

Fastening cables directly to support brackets with wire or plastic ties will not be accepted. All cabling shall be neatly laced, dressed and supported. Retainer Clips shall be used on each 110-type block to secure jumper wires on the wiring block(s).

The contractor shall be responsible for cross-connects between the cabling terminations at the Entrance Room and the SNI. It shall be the responsibility of the Contractor, to work with the Owner and Site Coordinator(s) and provide the necessary assistance to allow Owner and/or Telephone Company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross connect documentation, general wiring overview and cable pair identification.

The contractor shall be responsible for removal and disposal of all existing station cable.

Equipment Rack (Free Standing)

Equipment racks shall be furnished and installed in the following quantities:

TR#1 (Rm. 104)

two

The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. Rack shall also be stabilized by extending a brace extending to the wall. Alternately, overhead cable tray over which the cabling accesses the equipment rack(s) shall provide this function.

A space between the rack upright and the wall (~4 inches) should be planned to allow for cabling in that area. The rear of the rack should be ~40 inches from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40 inches workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Engineer for resolution prior to installation.

All hardware and equipment is to be mounted between 18 inches and 79 inches above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware should be reviewed and approved by the Engineer and Site Coordinator(s) prior to installation.

Equipment Rack shall be equipped with cable management hardware on both the front and back of rack as to allow an orderly and secure routing of twisted pair cabling to the data patch panels. At minimum, one such Horizontal Jumper Management Panel shall be placed below each Fiber Optic Patch Panel installed by the Contractor. Additional Jumper Management panels may be required pending installation of other cable types on the rack. Refer to other sections for guidance.

The rack(s) shall be grounded to the Telecommunications Ground Busbar (TGB) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket or GREEN jacket with one or more yellow stripes). (See NEC 2002, section 250.119.)

Identification and Labeling

Refer to Section 16075 "Electrical Identification" for Identification and Labeling guidelines for this Project.

All Copper Backbone and Station Cables, Outlet Faceplates and Termination components (e.g. Voice Field & Data Patch Panel) shall be clearly labeled.

Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used.

Work by Owner

Installation of network equipment.

Cooperation

The Contractor shall cooperate with other trades and State personnel in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the State, provided such decision is reached prior to actual installation. The Contractor shall check the location of electrical outlets with respect to other installations before installing.

TESTING AND ACCEPTANCE**General**

The contractor is responsible to perform acceptance tests as indicated below for each sub-system (e.g. backbone, station, etc.) as it is completed.

All tests shall be documented.

The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of the proposed test plan for each cable type including equipment to use used, set-up, test frequencies or wavelengths, results format, etc. The method of testing shall be approved by the Engineer.

The Contractor shall visually inspect all cabling and termination points to insure that they are complete and conform to the wiring pattern defined herein. The contractor shall provide the Engineer with a written certification that this inspection has been made

The Contractor shall conduct acceptance testing according to a schedule coordinated with the DSF. Representatives of the Owner may be in attendance to witness the test procedures. The contractor shall provide a minimum of one (1) week advance notice to the Engineer as to allow for such participation. The notification shall include a written description of the proposed conduct of the tests including copies of blank test result sheets to be used.

IMPORTANT: Failure to provide the above information shall be grounds for the Owner/Engineer to reject any and all Documentation of Results on related testing and to require a repeat of the affected test.

Tests related to connected equipment of others shall only be done with the permission and presence of Contractor involved. The Contractor shall ascertain that testing only as required to prove the wiring connections are correct.

The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Engineer, the contractor shall provide copies of the original test results.

All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the contractor. The applicable tests shall then be repeated.

Should it be found by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

Voice Cabling (Copper UTP)

Voice Station Cabling (Category 6)

Testing shall be done from the voice jack at the SIO to the voice 110 blocks/patch panel at the TR where the cables are terminated. When the SIO is located on/in the wall behind modular furniture, a patch cord may be inserted into the SIO to allow the furniture to be returned to its normal location. Cat 6 cable testing, in this case, will be done with the patch cord. The cabling must pass all Cat 6 TIA requirements. If the cable test fails only due to the length of the patch cord, the DSF will accept the cable as passing.

Horizontal "Station" cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on the Modular Jack). Any defective, split or mis-positioned pairs must be identified and corrected.

Testing of the Cabling Systems rated at TIA Category 6 shall be performed to confirm proper functioning and performance.

Where cross-connection of cabling sub-systems (e.g. Station & Backbone) by the Contractor is specified, each subsystem shall be tested separately as defined above followed by a Voice Channel Test after the cross-connection is complete.

Voice Channel

The end-to-end voice transmission between the building MDF and the Standard Information Outlet (Voice) including patch cords/jumper cables.

Voice Channel Test

The contractor shall perform a voice channel test on all voice cable pairs from the Standard Information Outlet (Voice) to the pair appearance at the MDF. All 4 pairs are to be free of shorts; verified for continuity, pair validity, polarity, and conductor position on the terminating blocks. Any mis-positioned pairs shall be identified and corrected. Any patch cords/jumper cables which cause the voice channel test to fail shall be replaced and the channel retested.

Data Station Cabling (Category 6)

Testing shall be from the Jack at the SIO to the Data Patch Panel at the TR on which the cables are terminated. When the SIO is located on/in the wall behind modular furniture, a patch cord may be inserted into the SIO to allow the furniture to be returned to its normal location. Cat 6 cable testing, in this case, will be done with the patch cord. The cabling must pass all Cat 6 TIA requirements. If the cable test fails only due to the length of the patch cord, the DSF will accept the cable as passing.

Horizontal "Station" cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on the Modular Jack). Any defective, split or mis-positioned pairs must be identified and corrected.

Testing of the Cabling Systems rated at TIA Category 6 shall be performed to confirm proper functioning and performance.

Category 6 Performance Testing

"In addition to the above, Performance Testing shall be performed on all cables. Testing of the Transmission Performance of station cables (Category 5e and Category 6) shall include the following:

1. Length
2. Attenuation
3. Pair to Pair NEXT Loss (new limits)
4. PSNEXT Loss
5. Pair to Pair ELFEXT Loss (Equal Level Far End Cross-talk)
6. PSEFEXT Loss
7. Propagation Delay
8. Delay Skew
9. Return Loss

Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify, "PASS" on each cable and display the specified parameters - comparing test values with standards based "templates" integral to the unit.

Category 6 testing shall be per ANSI/TIA/EIA 568B.2 Permanent Link test configurations and ANSI/TIA/EIA 568B.2 Category 6.

The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables. Worst-case performance at 20°C, based on a Horizontal Cable length of 90 meters and Equipment Cord length of 4 meters, shall be as follows:

Category 6 Test Parameters:

Category 6 Cable Permanent Link Test						
	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1	TIA/EIA 568B.2-1
	Insertion Loss	NEXT	PSNEXT	ELFEXT	PSELFEXT	Return Loss
Frequency	Attenuation	Worst Pair	Worst Loss	Case Pair Loss	Worst Pair to Loss	
Mhz	Max. dB	dB	dB	DB	dB	dB
1.00	1.9	65.0	62.0	64.2	61.2	19.1

4.00	3.5	64.1	61.8	52.1	49.1	21.0
8.00	5.0	59.4	57.0	46.1	43.1	21.0
10.00	5.5	57.8	55.5	44.2	41.2	21.0
16.00	7.0	54.6	52.2	40.1	37.1	20.0
20.00	7.9	53.1	50.7	38.2	35.2	19.5
25.00	8.9	51.5	49.1	36.2	33.2	19.0
31.25	10.0	50.0	47.5	34.3	31.3	18.5
62.50	14.4	45.1	42.7	28.3	25.3	16.0
100.00	18.6	41.8	39.3	24.2	21.2	14.0
200.00	27.4	36.9	34.3	18.2	15.2	11.0
250.00	31.1	35.3	32.7	16.2	13.2	10.0

Propagation Delay

The maximum propagation delay determined in accordance with the ANSI/TIA/EIA –568B.2 for a Permanent Link configuration shall be less than 498-ns measured at 10MHz. (Note: In determining the permanent link propagation delay, the propagation delay contribution of connecting hardware is assumed to not exceed 2.5 ns from 1 MHz to 100MHz).

Delay Skew

For all frequencies from 1 MHz to 250 MHz, Category 6 cable propagation delay skew shall not exceed 44ns/100m at 20°C, 40°C, and 60°C. In addition, the propagation delay skew between all pairs shall not vary more than +/- 10ns from the measured value at 20°C when measured at 40°C and 60°C. Compliance shall be determined using a minimum 100m of cable.

In order to establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an 8-position Category 6 Modular plug (8-pin) to facilitate testing. Net Propagation Velocity (NPV) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NPV data is available from the cable manufacturer for the exact cable type under test.

In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacement and changes as are necessary, and shall then repeat the test or tests which disclosed faulty or defective material, equipment or installation method, and shall make additional tests as the Engineer deems necessary at no additional expense to the project or user agency.

RG-6 - Testing

A Time Domain Reflectometer (TDR) shall be used to verify cable length and to test for cable faults and breaks. A step-function high resolution Time Domain Reflectometer shall be employed for this test, such as the TEKTRONIX 1502C or the HEWLETT-PACKARD 1415A. The results shall be automatically plotted on an X-Y plotter with a Y-axis voltage reflection coefficient resolution of 0.001 per division. The X-axis will resolve down to 1-inch of cable. The TDR will sweep the cable at a rate no greater than 50 feet per second, or such lower rate as necessary to resolve cable faults to the 1-inch and 0.001 VRC level.

The cables shall be terminated with its characteristic impedance, and in the case of 70-75 ohm cable, an appropriate matching pad shall be used to match the analyzer to the cable. Cable shall be rejected if any single fault is observed of amplitude greater than 0.003 voltage reflection coefficient. Characteristic impedance shall also be measured at 5% of nominal value.

Cyclic faults (such as cable reel stress and tie drawdown) shall be limited to a voltage reflection coefficient of 0.005.

Shielded Cabling (T1) - Testing

Shielded "T1" Cables shall be free of conductor-to-conductor and conductor-to-shield shorts.

All pairs shall be verified for continuity, pair validity and polarity and conductor position on the termination blocks (e.g. 110). Any mis-positioned pairs must be identified and corrected, and retested again

Shield and Drain wire continuity shall also be verified.

DOCUMENTATION

General

Upon completion of the installation, the contractor shall provide three (3) full Documentation Sets to the Engineer for approval. Documentation shall include the items detailed in the subsections below.

Documentation of Test Results shall be submitted in hard copy or in electronic form (preferred). Electronic documents may be submitted on CD-ROM (preferred) or 3½-inch diskettes for review and distribution. Where documentation provided in electronic form requires unique software (other than an MS-Word-compatible Word Processor or MS-Excel-spreadsheet) for viewing test results, the Contractor shall provide along with the above documentation, one (1) licensed copy of such software. The software shall run on a MICROSOFT *Windows*-based personal computer supplied by the Owner.

Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test result and *draft* as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.

The Engineer may request that a 10% random field re-test be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

Test Data - Copper Media

Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

Printouts generated for each cable by the wire test instrument (e.g. *PentaScanner*) shall be submitted as part of the documentation package. Alternately the contractor may furnish this information in electronic form on CD-ROM (preferred) or (3.5" diskette).

Cross-Connect Data

As noted above, it shall be the responsibility of the Contractor to work with the Owner and Site Coordinator(s) and provide the necessary assistance to allow Owner and/or Telephone Company personnel to make the necessary connections to establish telephone service on the new cable system. These activities include, but are not limited to (1) a general wiring overview and (2) detailed cross connect documentation (relating SIO I.D., Room Number and Riser pair). The latter shall be in the form of an electronic format database (dBase, MS Excel or convertible format).

AS-BUILT CONSTRUCTION DRAWINGS

Drawings included with the specifications set shall be modified by the contractor to denote as-built information.

The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

The Division of State Facilities through the Consultant will provide floor plans in paper and electronic (".dwg", *AutoCAD* rel. 2006) formats on which as-built construction information can be added. These documents will be modified accordingly by the contractor to denote as-built information as defined above and returned to the Consultant for acceptance. This information shall be supplied to the Consultant/Engineer no later than four (4) weeks prior to the scheduled occupancy of the affected floors.

The Contractors shall annotate the base drawings and return to the A/E in hard copy (same plot size as originals) and electronic (*AutoCAD* rel. 2006) form.

Each drawing submitted by the Contractor as part of the Project Documentation shall be identified as an "As-built" drawing and include the following (1) The Contractor name and/or logo (2) The date of the drawing.

All fonts, color, layer, Model Space/Paper Space conventions established in the base drawings shall be retained by the Contractor in preparation of the As-built drawings.

Prior to generation of the drawings, the Contractor shall provide a sample file and test plot to the Engineer for review and approval.

All documentation, including hard copy and electronic forms shall become the property of the State.

WARRANTY

This Contractor shall guarantee all materials, equipment, etc., two (2) years from date of substantial completion of this work. In the case of data cabling the contractor shall furnish complete Category 6 system warranty consisting of no less than fifteen (15) years. This guarantee shall include all labor, material and travel time.

END OF SECTION 16741

END OF ELECTRICAL SECTION

ADDITIONAL SPECIAL PROVISION 2

Apprenticeship Training.

- A. The contractor and its subcontractors agree, in the performance of this Contract, to employ apprentices in accordance with the requirements as described in Part B below, as established by the Department of Workforce Development in accordance with State of Wisconsin Executive Order No. 108, dated June 29, 2005.
- B. The contractor and subcontractors employing five (5) or more craft workers of trades with apprentice programs in the state of Wisconsin shall meet one of the following requirements:
 - 1. Employ or have employed at any time during the current or previous calendar year the maximum number of apprentices allowed by the training ratio for each trade included in the bid; or
 - 2. Employ or have employed at any time during the current or previous calendar year a skilled workforce of at least five (5) percent apprentices for projects performed under contract to DOT; or
 - 3. Employ apprentices on a contract jobsite at the maximum ratio or, where the ratio is not jobsite specific, at five (5) percent of the contract hours for work performed under contract to DOT; or
 - 4. Agree that "new hire apprentices" will be engaged at least at the maximum ratio of journey level workers to apprentices allowed under the standards established by the Department of Workforce Development.
- C. In the event of failure to meet these ratios, the contractor shall be given an opportunity to demonstrate that every good faith effort to meet this commitment has been made.
- D. No contract shall be executed or subcontract approved unless the contractor or subcontractors are currently approved as a Wisconsin Trade Trainer or has applied for approval as an Apprenticeship Trade Trainer to the Department of Workforce Development and agrees to an acceptable apprenticeship program which includes specific ratios of apprentices in skill trades which have been determined as apprentice able by the Department of Workforce Development.
- E. The contractor and subcontractor shall maintain records to demonstrate compliance with these apprenticeship requirements.
- F. Reasonable exemptions and modifications to and from any or all of these requirements will be determined by the Department of Workforce Development. A request for an exemption or modification, with justification, shall be made in writing, addressed to Department of Workforce Development, Bureau of Apprenticeship Standards, PO Box 7972, Madison, WI 53707.

ADDITIONAL SPECIAL PROVISION 3

Disadvantaged Business Enterprise Development. This item shall consist of concerted efforts by the contractor as part of its affirmative action responsibilities to train and develop minority business enterprises to become fully qualified contractors in the transportation construction field. Hereafter, minority business enterprise refers to businesses owned or controlled by socially and economically disadvantaged person(s) as certified by the Wisconsin Department of Transportation. It is the intention of this provision that firms owned and controlled by women be included as a presumptive group within the definition of Disadvantaged Business Enterprise (DBE).

The contractor will aggressively solicit DBE subcontractor and/or supplier quotes and incorporate them in its bid for work on this project by making systematic written and verbal contact with DBEs likely to have an interest in transportation construction work.

In this contract, the contractor shall procure services, materials, or subcontract the minimum percentage as shown on the cover of the Highway Work Proposal of the total amount bid to one or more certified DBEs. The Department maintains and furnishes the list of DBEs considered certified. If the proposed DBE is uncertified, the contractor must appeal to the Department to establish the eligibility of the DBE to become certified. This goal may be accomplished through the use of any combination of ethnic or women owned businesses certified as DBEs by the Department.

It is the intent of this specification that the percentage goal specified be fulfilled as indicated. However, if the contractor considers such fulfillment to be impossible of attainment, and if the contractor can demonstrate to the satisfaction of the Department that such utilization is not feasible, the Department may accept a varying percentage in lieu of the designated percentage for the DBE classification.

The contractor is encouraged to develop DBEs in areas of construction where these firms have traditionally been non-competitive. Therefore, the DBE goal on this contract may be reduced by the Department up to 50 percent for DBE work in the non-traditional construction categories of: concrete paving, asphalt paving, excavating and heavy grading, aggregate production, structures and major culvert installation. Any goal reduction is discretionary by the Department and will only be granted where it is clear the intended work will benefit the development and experience of the DBE.

Credit toward the required DBE goal is allowed for supplies and materials furnished by DBEs. However, the DBEs must assume the actual contractual responsibilities for furnishing the supplies and materials and also manufacture them. For these purposes, a manufacturer is a supplier that either produces goods from raw materials or substantially alters them before resale. When the supplier is not the manufacturer, only 60 percent of the expenditure to the supplier may be credited toward the DBE goal, provided the supplier performs a commercially useful function in the transaction.

Nevertheless, in order for the Department to execute a contract with a bidder that has failed to meet the specified DBE contract goal, the Department must determine that the bidder's good faith efforts were those that, given all relevant circumstances, a bidder activity and aggressively seeking to meet the goal would make.

Good faith efforts are to include contacts with the Department's Office of Disadvantaged Business Programs. In determining whether a contractor has made good faith efforts, the Department will usually look not only at the different kinds of efforts that the bidder has made, but also the quantity and intensity of those efforts. Efforts that are merely pro forma are not good faith efforts to meet the goal. Even if the efforts are sincerely motivated, they are not considered to be good faith efforts if, given all relevant circumstances, they could not

reasonably be expected to produce a level of DBE participation sufficient to meet the goal.

Within ten working 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 subcontract or supply agreement and the dollar amount of such items of work. Failure by the contractor to furnish the necessary information within the specified time frame does not negate the Department's right to award and execute the contract; however, good faith efforts after the submittal requirement will be discounted. Delay in fulfilling this requirement shall not constitute a cause for extension of the contract time. All other aspects of this minority business enterprise requirement shall be in accordance with appropriate provisions of Part 26 of Volume 49 of the Code of Federal Regulations entitled "Participation by Minority Business Enterprises in Department of Transportation Programs."

The contractor shall also provide or arrange for direct assistance to the DBEs in such areas as providing information to prepare intelligent quotations, insuring that the DBE can read and understand highway plans, assisting in reaching a full understanding of the Standard Specifications and contract requirements applicable to the DBE portion of the work, appropriate cost accounting and other business practices, and other actions aimed at continued development of the DBE into a viable highway contracting business.

The contractor shall maintain records and may be required to furnish periodic reports documenting its performance under this item.

The work herein prescribed will not be paid for separately, but will be considered incidental to other items of work included in the contract.

Failure on the part of the bidder to meet the DBE goal and to meet an adequate level of good faith efforts will, at the discretion of the Department, be deemed failure to execute the contract, be just cause of the cancellation of the award, and such other actions as deemed appropriate.

The entire provisions of this item do not apply if the bidder, excluding joint ventures, is a certified DBE.

ADDITIONAL SPECIAL PROVISION 4

Payment to all Subcontractors. Within 10 calendar days of receipt by a contractor of a progress payment for work performed, materials furnished, or materials stockpiled by a subcontractor, the contractor shall pay that subcontractor for all work satisfactorily performed and for all materials furnished or stockpiled.

The contractor agrees further to release retainage amounts to each subcontractor within 10 calendar days after the subcontractor's work is satisfactorily completed. In addition, whenever the Department reduces the contract retainage amount, within 10 calendar days of receipt by a contractor of a retainage payment, the contractor must reduce the total amount retained from subcontractors to no more than remains retained by the Department.

The contractor shall pay the subcontractor within the time frames described above unless the contractor complies with both of the following within 10 calendar days of receiving the Department's progress payment:

- 1) The contractor notifies the subcontractor in writing that the work is not satisfactorily completed.
- 2) The contractor requests approval from the Department to delay payment because the subcontractor has not satisfactorily completed the work.

The contractor's request for approval should include the written notification to the subcontractor and shall provide sufficient documentation of good cause to assist the engineer in making a timely decision. If the engineer does not grant approval, the contractor shall pay the subcontractor within 10 calendar days of the Department's decision.

All subcontracting agreements made by a contractor shall include the above provisions and shall be binding on all contractors and subcontractors.

The contractor certifies compliance with the requirements of this Additional Special Provision by signing the contract. This clause applies to both DBE and non-DBE subcontractors.

ADDITIONAL SPECIAL PROVISION 6
MODIFICATIONS TO THE STANDARD SPECIFICATIONS

Make the following revisions to the 2003 edition of the standard specifications as modified by the 2005 supplement:

510.1 Description

Add the following to the end as paragraph two effective with the December 2005 letting:

- (2) This section also describes pile redriving in non-granular soils.

510.3.4.2 Bearing Value

Add the following to the end as paragraph three effective with the December 2005 letting:

- (3) Under the Pile Redriving bid item, drive one piling in each substructure unit to plan length unless the required bearing is obtained by piling bearing formula at a shorter length. If the bearing is not obtained in the plan length, allow the piling to set up for 48 hours; then re-tap. Determine the bearing capacity using the first 10 blows of the hammer. If bearing is still not obtained, splice additional length to the piling, drive the piling an additional 10 feet (3 m) or to the depth the engineer directs, and repeat the 48-hour set up and retapping process. Add more length and repeat this entire process until the required bearing is obtained. After obtaining the required bearing, drive other piling in the substructure to the same tip elevation.

510.4 Measurement

Add the following to the end as paragraph three effective with the December 2005 letting:

- (3) The department will measure Pile Redriving as each individual substructure acceptably completed, measured as one 48-hour setoff and re-driving of one piling per substructure.

510.5.1 General

Replace paragraph one with the following effective with the December 2005 letting:

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
510.2005	Preboring CIP Concrete Piling	LF
510.3000 - 3099	Piling CIP Concrete Delivered and Driven (inch)	LF
510.5000	Pile Redriving	EACH

510.5.4 Pile Redriving

Add the following new subsection effective with the December 2005 letting:

510.5.4 Pile Redriving

- (1) Payment for Pile Redriving is full compensation for time delays, extra movement of equipment, and re-tapping one piling per substructure.

511.1 Description

Replace paragraph two with the following effective with the December 2005 letting:

- (2) This section also describes furnishing and attaching pile points to steel piling, and preboring piling into sound rock.

511.3.7 Pile Redriving

Delete the entire text and replace the subsection title with the following effective with the December 2005 letting:

511.3.7 (Vacant)

511.4 Measurement

Replace paragraphs three and four with the following effective with the December 2005 letting:

- (3) The department will measure Piling Steel Preboring by the linear foot, measured from the bottom of the footing to the bottom of the hole.

511.5.1 General

Replace paragraph one with the following effective with the December 2005 letting:

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
511.2100 - 2199	Piling Steel Delivered and Driven HP (inch) (lb)	LF
511.3000	Pile Points	EACH
511.6000	Piling Steel Preboring	LF

511.5.4 Pile Redriving

Delete the entire text and replace the subsection title with the following effective with the December 2005 letting:

511.5.4 (Vacant)

648.3.2 Locating No-Passing Zones

Replace paragraph one with the following effective with the January 2006 letting:

- (1) Locate the termini of all no-passing zones as the plans show or the contract specifies. Report to the engineer before beginning work under the Locating No-Passing Zones bid item.

Replace paragraphs three and four with the following effective with the January 2006 letting:

- (3) Spot both ends of no-passing zones, to an accuracy of 52 feet (16 m), where the highway has inadequate sight distance. Conform to the sight distance requirements as follows:

POSTED SPEED LIMIT	SPOTTING	MINIMUM DISTANCE ^[1]
	SIGHT DISTANCE	BETWEEN ZONES
in mph (km/h)	in feet (m)	in feet (m)
25 - 30 (40 - 50)	528 (161)	528 (161)
35 - 40 (55 - 65)	686 (209)	528 (161)
45 - 50 (70 - 80)	845 (258)	686 (209)
55 (90)	see ^[2]	792 (241)

^[1] If the distance between 2 successive no-passing zones is less than the minimum distance between zones, connect the 2 zones.

^[2] The spotting sight distance is specified in the special provisions.

- (4) On horizontal curves, no part of the line-of-sight can extend outside the shoulder.

Replace paragraph seven with the following effective with the January 2006 letting:

- (7) On state trunk highways, spot a 500 foot (150 m) no-passing barrier line at the following locations:
1. Approaches to intersections with a stop sign or traffic signal facing traffic on the highway being surveyed.
 2. Approaches to a divided highway.
 3. Approaches to an intersection with another state trunk highway.
 4. Other locations as the engineer directs.

Replace paragraph eleven with the following effective with the January 2006 letting:

- (11) Upon completing the work under this section, furnish the engineer 4 copies of an odometer log locating features to the 1/100 of a mile (0.01 km) for each road surveyed. Make all log points specific and readily identifiable. Include the following:
- The cardinal direction of travel.
 - The beginning and ending of each no-passing barrier line in both directions.
 - The speed criteria for each zone.
 - The location of all permanent landmarks

BID ITEMS ADDED

Add these bid items effective with the December 2005 letting:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
510.5000	Pile Redriving	EACH

BID ITEMS RETIRED

Retire these bid items effective with the December 2005 letting:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
511.5000	Pile Redriving	EACH

REQUIRED CONTRACT PROVISIONS FEDERAL-AID CONSTRUCTION CONTRACTS

- [I. General](#)
- [II. Nondiscrimination](#)
- [III. Nonsegregated Facilities](#)
- [IV. Payment of Predetermined Minimum Wage](#)
- [V. Statements and Payrolls](#)
- [VI. Record of Materials, Supplies, and Labor](#)
- [VII. Subletting or Assigning the Contract](#)
- [VIII. Safety: Accident Prevention](#)
- [IX. False Statements Concerning Highway Projects](#)
- [X. Implementation of Clean Air Act and Federal Water Pollution Control Act](#)
- [XI. Certification Regarding Debarment, Suspension Ineligibility, and Voluntary Exclusion](#)
- [XII. Certification Regarding Use of Contract Funds for Lobbying](#)

ATTACHMENTS

- [A. Employment Preference for Appalachian Contracts \(included in Appalachian contracts only\)](#)

I. GENERAL

1. 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.

2. Except as otherwise provided for in each section, the contractor shall insert in each subcontract all of the stipulations contained in these Required Contract Provisions, and further require their inclusion in any lower tier subcontract or purchase order that may in turn be made. The Required Contract Provisions shall not be incorporated by reference in any case. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with these Required Contract Provisions.

3. A breach of any of the stipulations contained in these Required Contract Provisions shall be sufficient grounds for termination of the contract.

4. A breach of the following clauses of the Required Contract Provisions may also be grounds for debarment as provided in 29 CFR 5.12:

- Section I, paragraph 2;
- Section IV, paragraphs 1, 2, 3, 4, and 7;
- Section V, paragraphs 1 and 2a through 2g.

5. Disputes arising out of the labor standards provisions of Section IV (except paragraph 5) and Section V of these Required Contract Provisions shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the U.S. Department of Labor (DOL) as set forth in 29 CFR 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 DOL, or the contractor's employees or their representatives.

6. **Selection of Labor:** During the performance of this contract, the contractor shall not:

a. discriminate against labor from any other State, possession, or territory of the United States (except for employment preference for Appalachian contracts, when applicable, as specified in Attachment A), or

b. employ convict labor for any purpose within the limits of the project unless it is labor performed by convicts who are on parole, supervised release, or probation.

II. NONDISCRIMINATION

(Applicable to all Federal-aid construction contracts and to all related subcontracts of \$10,000 or more.)

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 and 41 CFR 60) 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 Equal Opportunity Construction Contract Specifications set forth under 41 CFR 60-4.3 and the provisions of the American 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 State highway agency (SHA) and the Federal Government in carrying out EEO obligations and in their review of his/her activities under the contract.

b. The contractor will accept as his 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, preapprenticeship, and/or on-the-job training."

2. **EEO Officer:** The contractor will designate and make known to the SHA contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active contractor program of EEO 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 minority group employees.

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 minority groups 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 minority group applicants. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group 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, he is expected to observe the provisions of that agreement to the extent that the system permits the contractor's compliance with EEO contract provisions. (The DOL has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Executive Order 11246, as amended.)

c. The contractor will encourage his present employees to refer minority group applicants for employment. Information and procedures with regard to referring minority group 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 his 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 his avenues of appeal.

6. **Training and Promotion:**

a. The contractor will assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.

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. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision.

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 minority group and women employees 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 his/her best efforts to obtain the cooperation of such unions to increase opportunities for minority groups and women within the unions, and to effect referrals by such unions of minority and female employees. 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 best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.

b. The contractor will use best 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 SHA 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 minority and women 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 minority group persons and women. (The DOL has held that it shall be no excuse that the union with which the contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees.) 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 SHA.

8. **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.

a. The contractor shall notify all potential subcontractors and suppliers of his/her EEO obligations under this contract.

b. Disadvantaged business enterprises (DBE), as defined in 49 CFR 23, shall have equal opportunity to compete for and perform subcontracts which the contractor enters into pursuant to this contract. The contractor will use his best efforts to solicit bids from and to utilize DBE subcontractors or subcontractors

with meaningful minority group and female representation among their employees. Contractors shall obtain lists of DBE construction firms from SHA personnel.

c. The contractor will use his best efforts to ensure subcontractor compliance with their EEO obligations.

9. 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 completion of the contract work and shall be available at reasonable times and places for inspection by authorized representatives of the SHA and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number 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;

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees; and

(4) The progress and efforts being made in securing the services of DBE subcontractors or subcontractors with meaningful minority and female representation among their employees.

b. The contractors will submit an annual report to the SHA 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. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data.

III. NONSEGREGATED FACILITIES

(Applicable to all Federal-aid construction contracts and to all related subcontracts of \$10,000 or more.)

a. By submission of this bid, the execution of this contract or subcontract, or the consummation of this material supply agreement or purchase order, as appropriate, the bidder, Federal-aid construction contractor, subcontractor, material supplier, or vendor, as appropriate, certifies that the firm does not maintain or provide for its employees any segregated facilities at any of its establishments, and that the firm does not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The firm agrees that a breach of this certification is a violation of the EEO provisions of this contract. The firm further certifies that no employee will be denied access to adequate facilities on the basis of sex or disability.

b. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, timeclocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive, or are, in fact, segregated on the basis of race, color, religion, national origin, age or disability, because of habit, local custom, or otherwise. The only exception will be for the disabled when the demands for accessibility override (e.g. disabled parking).

c. The contractor agrees that it has obtained or will obtain identical certification from proposed subcontractors or material suppliers prior to award of subcontracts or consummation of material supply agreements of \$10,000 or more and that it will retain such certifications in its files.

IV. PAYMENT OF PREDETERMINED MINIMUM WAGE

(Applicable to all Federal-aid construction contracts exceeding \$2,000 and to all related subcontracts, except for projects located on roadways classified as local roads or rural minor collectors, which are exempt.)

1. General:

a. All mechanics and laborers 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 (29 CFR 3) issued by the Secretary of Labor under the Copeland Act (40 U.S.C. 276c)] the full amounts of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment. The payment shall be computed at wage rates not less than those contained in the wage determination of the Secretary of Labor (hereinafter "the wage determination") which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor or its subcontractors and such laborers and mechanics. The wage determination (including any additional classifications and wage rates conformed under paragraph 2 of this Section IV and the DOL poster (WH-1321) or Form FHWA-1495) 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. For the purpose of this Section, contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b)(2) of the Davis-Bacon Act (40 U.S.C. 276a) on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of Section IV, paragraph 3b, hereof. Also, for the purpose of this Section, 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 paragraphs 4 and 5 of this Section IV.

b. 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.

c. All rulings and interpretations of the Davis-Bacon Act and related acts contained in 29 CFR 1, 3, and 5 are herein incorporated by reference in this contract.

2. Classification:

a. The SHA contracting officer shall require that any class of laborers or mechanics employed under the contract, which is not listed in the wage determination, shall be classified in conformance with the wage determination.

b. The contracting officer shall approve an additional classification, wage rate and fringe benefits only when the following criteria have been met:

(1) the work to be performed by the additional classification requested is not performed by a classification in the wage determination;

(2) the additional classification is utilized in the area by the construction industry;

(3) the proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination; and

(4) with respect to helpers, when such a classification prevails in the area in which the work is performed.

c. If the contractor or subcontractors, as appropriate, the laborers and mechanics (if known) to be employed in the additional classification 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 DOL, Administrator of the Wage and Hour Division, Employment Standards

Administration, Washington, D.C. 20210. The Wage and Hour 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.

d. In the event the contractor or subcontractors, as appropriate, the laborers or mechanics to be employed in the additional 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. Said 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

e. The wage rate (including fringe benefits where appropriate) determined pursuant to paragraph 2c or 2d of this Section IV shall be paid to all workers performing work in the additional classification from the first day on which work is performed in the classification.

3. Payment of Fringe Benefits:

a. 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 or subcontractors, as appropriate, shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly case equivalent thereof.

b. If the contractor or subcontractor, as appropriate, does not make payments to a trustee or other third person, he/she may consider as a 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.

4. Apprentices and Trainees (Programs of the U.S. DOL) and Helpers:

a. Apprentices:

(1) 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 DOL, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State apprenticeship agency recognized by the Bureau, or if a person is employed in his/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 Bureau of Apprenticeship and Training or a State apprenticeship agency (where appropriate) to be eligible for probationary employment as an apprentice.

(2) The allowable ratio of apprentices to journeyman-level employees 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 employee 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 listed in 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 or subcontractor 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-level hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

(3) 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 journeyman-level 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 for the Wage and Hour Division determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

(4) In the event the Bureau of Apprenticeship and Training, or a State apprenticeship agency recognized by the Bureau, withdraws approval of an apprenticeship program, the contractor or subcontractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the comparable work performed by regular employees until an acceptable program is approved.

b. Trainees:

(1) 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 DOL, Employment and Training Administration.

(2) The ratio of trainees to journeyman-level employees on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. 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.

(3) Every trainee must be paid at not less than the rate specified in the approved program for his/her level of progress, expressed as a percentage of the journeyman-level 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-level wage rate on the wage determination which provides for less than full fringe benefits for apprentices, in which case such trainees shall receive the same fringe benefits as apprentices.

(4) In the event the Employment and Training Administration withdraws approval of a training program, the contractor or subcontractor 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. Helpers:

Helpers will be permitted to work on a project if the helper classification is specified and defined on the applicable wage determination or is approved pursuant to the conformance procedure set forth in Section IV.2. Any worker listed on a payroll at a helper wage rate, who is not a helper under a approved definition, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed.

5. 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.

6. Withholding:

The SHA shall upon its own action or upon written request of an authorized representative of the DOL withhold, or cause to be withheld, from the contractor or subcontractor 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, as 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 SHA contracting officer 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.

7. Overtime Requirements:

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers, mechanics, watchmen, or guards (including apprentices, trainees, and helpers described in paragraphs 4 and 5 above) shall require or permit any laborer, mechanic, watchman, or guard in any workweek in which he/she is employed on such work, to work in excess of 40 hours in such workweek unless such laborer, mechanic, watchman, or guard receives compensation at a rate not less than one-and-one-half times his/her basic rate of pay for all hours worked in excess of 40 hours in such workweek.

8. Violation:

Liability for Unpaid Wages; Liquidated Damages: In the event of any violation of the clause set forth in paragraph 7 above, the contractor and any subcontractor responsible thereof shall be liable to the affected employee for his/her 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, mechanic, watchman, or guard employed in violation of the clause set forth in paragraph 7, in the sum of \$10 for each calendar day on which such employee was required or permitted to work in excess of the standard work week of 40 hours without payment of the overtime wages required by the clause set forth in paragraph 7.

9. Withholding for Unpaid Wages and Liquidated Damages:

The SHA shall upon its own action or upon written request of any authorized representative of the DOL withhold, or cause to be withheld, from any monies 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 8 above.

V. STATEMENTS AND PAYROLLS

(Applicable to all Federal-aid construction contracts exceeding \$2,000 and to all related subcontracts, except for projects located on roadways classified as local roads or rural collectors, which are exempt.)

1. Compliance with Copeland Regulations (29 CFR 3):

The contractor shall comply with the Copeland Regulations of the Secretary of Labor which are herein incorporated by reference.

2. Payrolls and Payroll Records:

a. Payrolls and basic records relating thereto shall be maintained by the contractor and each subcontractor during the course of the work and preserved for a period of 3 years from the date of completion of the contract for all laborers, mechanics, apprentices, trainees, watchmen, helpers, and guards working at the site of the work.

b. The payroll records shall contain the name, social security number, and address of each such employee; his or her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalent thereof 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. In addition, for Appalachian contracts, the payroll records shall contain a notation indicating whether the employee does, or does not, normally reside in the labor area as defined in Attachment A, paragraph 1. Whenever the Secretary of Labor, pursuant to Section IV, paragraph 3b, has found 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 and each subcontractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, that the plan or program has been communicated in writing to the laborers or mechanics affected, and show the cost anticipated or the actual cost incurred in providing benefits. Contractors or subcontractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprentices and trainees, and ratios and wage rates prescribed in the applicable programs.

c. Each contractor and subcontractor shall furnish, each week in which any contract work is performed, to the SHA resident engineer a payroll of wages paid each of its employees (including apprentices, trainees, and helpers, described in Section IV, paragraphs 4 and 5, and watchmen and guards engaged on work during the preceding weekly payroll period). The payroll submitted shall set out accurately and completely all of the information required to be maintained under paragraph 2b of this Section V. This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal stock number 029-005-0014-1), U.S. Government Printing Office, Washington, D.C. 20402. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors.

d. Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his/her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) that the payroll for the payroll period contains the information required to be maintained under paragraph 2b of this Section V and that such information is correct and complete;

(2) that such 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 the Regulations, 29 CFR 3;

(3) that each laborer or mechanic has been paid not less than the applicable wage rate and fringe benefits or cash equivalent for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

e. 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 2d of this Section V.

f. The falsification of any of the above certifications may subject the contractor to civil or criminal prosecution under 18 U.S.C. 1001 and 31 U.S.C. 231.

g. The contractor or subcontractor shall make the records required under paragraph 2b of this Section V available for inspection, copying, or transcription by authorized representatives of the SHA, the FHWA, or the DOL, 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 SHA, the FHWA, the DOL, or all may, after written notice to the contractor, sponsor, applicant, or owner, take such actions 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.

VI. RECORD OF MATERIALS, SUPPLIES, AND LABOR

1. On all Federal-aid contracts on the National Highway System, except those which provide solely for the installation of protective devices at railroad grade crossings, those which are constructed on a force account or direct labor basis, highway beautification contracts, and contracts for which the total final construction cost for roadway and bridge is less than \$1,000,000 (23 CFR 635) the contractor shall:

a. Become familiar with the list of specific materials and supplies contained in Form FHWA-47, "Statement of Materials and Labor Used by Contractor of Highway Construction Involving Federal Funds," prior to the commencement of work under this contract.

b. Maintain a record of the total cost of all materials and supplies purchased for and incorporated in the work, and also of the quantities of those specific materials and supplies listed on Form FHWA-47, and in the units shown on Form FHWA-47.

c. Furnish, upon the completion of the contract, to the SHA resident engineer on Form FHWA-47 together with the data required in paragraph 1b relative to materials and supplies, a final labor summary of all contract work indicating the total hours worked and the total amount earned.

2. At the prime contractor's option, either a single report covering all contract work or separate reports for the contractor and for each subcontract shall be submitted.

VII. SUBLETTING OR ASSIGNING THE CONTRACT

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 State. 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).

a. "Its own organization" shall be construed to include only workers employed and paid directly 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, assignee, or agent of the prime contractor.

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 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 VII 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 SHA 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 SHA 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 SHA has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

VIII. SAFETY: ACCIDENT PREVENTION

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 SHA 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. 333).

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. 333).

IX. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

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, the following notice 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:

**NOTICE TO ALL PERSONNEL ENGAGED ON FEDERAL-AID
HIGHWAY PROJECTS**

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 not more than \$10,000 or imprisoned not more than 5 years or both."

**X. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER
POLLUTION CONTROL ACT**

(Applicable to all Federal-aid construction contracts and to all related subcontracts of \$100,000 or more.)

By submission of this bid or the execution of this contract, or subcontract, as appropriate, the bidder, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any facility that is or will be utilized in the performance of this contract, unless such contract is exempt under the Clean Air Act, as amended (42 U.S.C. 1857 et seq., as amended by Pub.L. 91-604), and under the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq., as amended by Pub.L. 92-500), Executive Order 11738, and regulations in implementation thereof (40 CFR 15) is not listed, on the date of contract award, on the U.S. Environmental Protection Agency (EPA) List of Violating Facilities pursuant to 40 CFR 15.20.
2. That the firm agrees to comply and remain in compliance with all the requirements of Section 114 of the Clean Air Act and Section 308 of the Federal Water Pollution Control Act and all regulations and guidelines listed thereunder.
3. That the firm shall promptly notify the SHA of the receipt of any communication from the Director, Office of Federal Activities, EPA, indicating that a facility that is or will be utilized for the contract is under consideration to be listed on the EPA List of Violating Facilities.
4. That the firm agrees to include or cause to be included the requirements of paragraph 1 through 4 of this Section X in every nonexempt subcontract, and further agrees to take such action as the government may direct as a means of enforcing such requirements.

**XI. CERTIFICATION REGARDING DEBARMENT, SUSPENSION,
INELIGIBILITY AND VOLUNTARY EXCLUSION**

1. Instructions for Certification - Primary Covered Transactions:

(Applicable to all Federal-aid contracts - 49 CFR 29)

a. By signing and submitting this proposal, the prospective primary 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 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 primary 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 department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause of default.

d. The prospective primary participant shall provide immediate written notice to the department or agency to whom this proposal is submitted if any time the prospective primary 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," "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 rules implementing Executive Order 12549. You may contact the department or agency to which this proposal is submitted for assistance in obtaining a copy of those regulations.

f. The prospective primary 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 primary 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 Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

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 may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the nonprocurement portion of the "Lists of Parties Excluded From Federal Procurement or Nonprocurement Programs" (Nonprocurement List) which is compiled by the General Services Administration.

i. 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.

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.

* * * * *

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Primary Covered Transactions

1. The prospective primary participant 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 3-year period preceding this proposal been convicted of or had a civil judgement 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 offenses enumerated in paragraph 1b of this certification; and

d. Have not within a 3-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

2. Where the prospective primary 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 Covered Transactions:

(Applicable to all subcontracts, purchase orders and other lower tier transactions of \$25,000 or more - 49 CFR 29)

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," "primary covered transaction," "participant," "person," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.

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.

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 may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

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 Covered Transactions:

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 participation in this transaction 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.

* * * * *

XII. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

(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 his or her bid or proposal that he or she 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 PREFERENCE FOR APPALACHIAN CONTRACTS

(Applicable to Appalachian contracts only.)

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 he 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, he 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 1 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 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.

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:

<u>County</u>	<u>%</u>	<u>County</u>	<u>%</u>	<u>County</u>	<u>%</u>
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.

SEPTEMBER 2002

ADDITIONAL FEDERAL-AID PROVISIONS

BUY AMERICA

All steel and iron materials permanently incorporated in this project shall be domestic products and all manufacturing and coating processes for these materials 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.

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.

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 contracts.

While the wage rates shown are the minimum rates required by the contract to be paid during its life, this is 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).

Equal Rights Division
Labor Standards Bureau
P. O. Box 8928
Madison, Wisconsin 53708
(608) 266-6860

**FINAL DETERMINATION
ANNUAL PREVAILING WAGE RATE SURVEY DATA
DANE COUNTY**

Compiled by the State of Wisconsin
Department of Workforce Development
Pursuant to s. 103.50, Stats.
For All State Highway Projects
Issued on May 1, 2006

CLASSIFICATION: Contractors are required to call the Department of Workforce Development if there are any questions regarding the proper trade or classification to be used for any worker on a public works project.

OVERTIME: Time and one-half must be paid for all hours worked over 10 hours per day and 40 hours per calendar week and for all hours worked on Saturday, Sunday and the following six (6) 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.

FUTURE INCREASE: If indicated for a specific trade or occupation, the full amount of such increase MUST be added to the "TOTAL" indicated for such trade or occupation on the date(s) such increase(s) becomes effective.

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, whenever such pay is applicable.

SUBJOURNEY: Wage rates may be available for some of the classifications indicated below. Any employer that desires to use any subjourney classification on a project MUST request the applicable wage rate from the Department of Workforce Development PRIOR to the date such classification is used on such project. Form ERD-10880 is available for this purpose and can be obtained by writing to the Department of Workforce Development, Equal Rights Division, P.O. Box 8928, Madison, WI 53708.

<u>TRADE OR OCCUPATION</u>	<u>HOURLY BASIC RATE OF PAY</u>	<u>HOURLY FRINGE BENEFITS</u>	<u>TOTAL</u>
	\$	\$	\$
Bricklayer, Blocklayer or Stonemason	15.00	0.00	15.00
Carpenter	24.91	11.36	36.27
Future Increase(s): Add \$1.35 on 5/28/06; Add \$1.35 on 5/27/07			
Cement Finisher	24.29	10.82	35.11
Electrician	38.58	1.23	39.81
Fence Erector	18.75	3.50	22.25
Ironworker	27.05	13.71	40.76
Future Increase(s): Add \$1.65 6/1/2006; Add \$1.65 6/1/2007.			
Line Constructor (Electrical)	29.20	13.20	42.40
Painter	19.00	5.10	24.10
Pavement Marking Operator	23.46	9.45	32.91
Piledriver	25.41	11.36	36.77
Future Increase(s): Add \$1.35 on 5/28/06; Add \$1.35 on 5/27/07			
Roofer or Waterproofor	21.40	3.96	25.36
Teledata Technician or Installer	19.61	8.48	28.09
Tuckpointer, Caulker or Cleaner	19.95	5.55	25.50
Underwater Diver (Except on Great Lakes)	24.81	10.61	35.42
Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	27.52	13.70	41.22
Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	25.07	11.78	36.85
Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	20.44	10.58	31.02
Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	18.98	9.97	28.95
Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	20.98	9.17	30.15

<u>TRADE OR OCCUPATION</u>	<u>HOURLY BASIC RATE OF PAY</u>	<u>HOURLY FRINGE BENEFITS</u>	<u>TOTAL</u>
	\$	\$	\$
TRUCK DRIVERS			
Single Axle or Two Axle	21.00	12.26	33.26
Future Increase(s): Add \$.80 on 5/1/06; Add \$1.45 5/1/2007; Add \$1.45 5/1/2008; Add \$1.65 5/1/2009; Add \$1.65 5/1/10			
Three or More Axle	21.00	12.26	33.26
Future Increase(s): Add \$.80 on 5/1/06; Add \$1.45 5/1/2007; Add \$1.45 5/1/2008; Add \$1.65 5/1/2009; Add \$1.65 5/1/10			
Articulated, Euclid, Dumptor, Off Road Material Hauler	20.82	14.50	35.32
Future Increase(s): Add \$1.55 on 6/1/06; Add \$1.60 on 6/1/07; Add \$1.65 on 6/1/08			
Pavement Marking Vehicle	19.32	10.69	30.01
Shadow or Pilot Vehicle	19.60	12.01	31.61
Truck Mechanic	21.00	12.26	33.26
Future Increase(s): Add \$.80 on 5/1/06; Add \$1.45 5/1/2007; Add \$1.45 5/1/2008; Add \$1.65 5/1/2009; Add \$1.65 5/1/10			
LABORERS			
General Laborer	21.80	9.75	31.55
Future Increase(s): Add \$1.40 on 6/1/06; Add \$1.45 on 6/1/07; Add \$1.50 on 6/1/08; Add \$1.35 on 6/1/09. Premium Pay: Add \$.10 for topman, air tool operator, vibrator or tamper operator (mechanical hand operated), chain saw operator and demolition burning torch laborer; Add \$.15 for bituminous worker (raker and luteman), formsetter (curb, sidewalk and pavement) and strike off man; Add \$.20 for blaster and powderman; Add \$.25 for bottomman; Add \$.35 for line and grade specialist; Add \$.45 for pipelayer.			
Landscaper	21.80	9.75	31.55
Future Increase(s): Add \$1.40 on 6/1/06; Add \$1.45 on 6/1/07; Add \$1.50 on 6/1/08; Add \$1.35 on 6/1/09.			
Flagperson or Traffic Control Person	18.15	9.75	27.90
Future Increase(s): Add \$1.40 on 6/1/06; Add \$1.45 on 6/1/07; Add \$1.50 on 6/1/08; Add \$1.35 on 6/1/09.			
Fiber Optic Laborer (Outside, Other Than Concrete Encased)	18.71	1.69	20.40
Railroad Track Laborer	12.31	1.46	13.77
HEAVY EQUIPMENT OPERATORS			
Crane, Tower Crane or Derrick, With or Without Attachments, With a Lifting Capacity of Over 100 Tons; Crane, Tower Crane or Derrick, With Boom, Leads and/or Jib Lengths Measuring 176 Feet or Over	28.27	14.50	42.77
Future Increase(s): Add \$1.55 on 6/1/06; Add \$1.60 on 6/1/07; Add \$1.65 on 6/1/08			
Crane, Tower Crane or Derrick, With or Without Attachments, With a Lifting Capacity of 100 Tons or Under; Crane, Tower Crane or Derrick, With Boom, Leads and/or Jib Lengths Measuring 175 Feet or Under; Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of 130,000 Lbs. or Over; Caisson Rig; Pile Driver; Dredge (Not Performing Work on the Great Lakes)	27.77	14.50	42.27
Future Increase(s): Add \$1.55 on 6/1/06; Add \$1.60 on 6/1/07; Add \$1.65 on 6/1/08			
Backhoe (Track Type) Having a Mfgr.'s Rated Capacity of Under 130,000 Lbs.; Tractor or Truck Mounted Hydraulic Backhoe; Gradall (Cruz-Aire Type); Mechanic or Welder; Bulldozer or Endloader; Grader or Motor Patrol; Scraper (Self propelled or Tractor Drawn) 5 cu yards or more capacity;	27.27	14.50	41.77

<u>TRADE OR OCCUPATION</u>	<u>HOURLY BASIC RATE OF PAY</u>	<u>HOURLY FRINGE BENEFITS</u>	<u>TOTAL</u>
	\$	\$	\$
Concrete Pump, Grout Pump or Concrete Conveyor (Rotec or Bidwell Type); Concrete Breaker (Manual or Remote); Concrete Batch Plant; Power Subgrader; Concrete Spreader; Concrete Paver; Concrete Grinder or Planing Machine; Concrete Conveyor System; Concrete Slipform Placer Curb and Gutter Machine; Asphalt Plant; Asphalt Paver; Asphalt Screed; Asphalt Milling Machine; Roller (Over 5 Ton); Shouldering Machine; Boring Machine (Horizontal, Vertical or Directional); Air Track, Rotary or Percussion Drilling Machine; Straddle Carrier or Travel Lift; Trencher; Post Hole Digger or Driver; Tug or Launch (Not Performing Work on the Great Lakes) Future Increase(s): Add \$1.55 on 6/1/06; Add \$1.60 on 6/1/07; Add \$1.65 on 6/1/08			
Farm or Industrial Type Tractor; Greaser; Compactor (Self-Propelled); Concrete Saw (Vermeer Type); Concrete Bump Cutter or Grooving Machine; Tining or Curing Machine; Roller (5 Tons or Under); Broom or Sweeper; Environmental Burner Future Increase(s): Add \$1.55 on 6/1/06; Add \$1.60 on 6/1/07; Add \$1.65 on 6/1/08	27.01	14.50	41.51
Oiler; Crusher, Screening or Wash Plant; Air Compressor; Generator; Pump (3 Inch or Over) or Well Points; Forklift; Skid Steer Loader (With or Without Attachments); Skid Rig; Stump Chipper; Mulcher; Vibratory Hammer or Extractor Future Increase(s): Add \$1.55 on 6/1/06; Add \$1.60 on 6/1/07; Add \$1.65 on 6/1/08	28.27	14.50	42.77
Fiber Optic Cable Equipment	29.15	12.90	42.05

The following statutory provisions apply to all state highway projects based on bids as provided in s. 84.06 (2), Stats. and are set forth below pursuant to the requirements of s. 103.50 (6), Stats.

(2) PREVAILING WAGE RATES AND HOURS OF LABOR. No person described in sub. (2m) in the employ of a contractor, subcontractor, agent or other person performing any work on a project under a contract based on bids as provided in s. 84.06 (2) to which the state is a party for the construction or improvement of any highway may be permitted to work a longer number of hours per day or per calendar week than the prevailing hours of labor determined under sub. (3); nor may he or she be paid a lesser rate of wages than the prevailing wage rate in the area in which the work is to be done determined under sub. (3); except that any such person may be permitted or required to work more than such prevailing hours of labor per day and per calendar week if he or she is paid for all hours worked in excess of the prevailing hours of labor at a rate of at least 1.5 times his or her hourly basic rate of pay.

(7) PENALTIES. (a) Except as provided in pars. (b), (d) and (f), any contractor, subcontractor or agent thereof who violates this section may be fined not more than \$200 or imprisoned for not more than 6 months or both. Each day that any such violation continues shall be considered a separate offense.

(b) Whoever induces any individual who seeks to be or is employed on any project that is subject to this section to give up, waive or return any part of the wages to which the individual is entitled under the contract governing such project, or who reduces the hourly basic rate of pay normally paid to an employee for work on a project that is not subject to this section during a week in which the employee works both on a project that is subject to this section and on a project that is not subject to this section, by threat not to employ, by threat of dismissal from such employment or by any other means is guilty of an offense under s. 946.15 (1).

(c) Any person employed on a project that is subject to this section who knowingly permits a contractor, subcontractor or agent thereof to pay him or her less than the prevailing wage rate set forth in the contract governing such project, who gives up, waives or returns any part of the compensation to which he or she is entitled under the contract, or who gives up, waives or returns any part of the compensation to which he or she is normally entitled for work on a project that is not subject to this section during a week in which the person works both on a project that is subject to this section and on a project that is not subject to this section, is guilty of an offense under s. 946.15 (2).

(d) Whoever induces any individual who seeks to be or is employed on any project that is subject to this section to permit any part of the wages to which the individual is entitled under the contract governing such project to be deducted from the individual's pay is guilty of an offense under s. 946.15 (3), unless the deduction would be permitted under 29 CFR 3.5 or 3.6 from an individual who is working on a project that is subject to 40 USC 276c.

(e) Any person employed on a project that is subject to this section who knowingly permits any part of the wages to which he or she is entitled under the contract governing such project to be deducted from his or her pay is guilty of an offense under s. 946.15 (4), unless the deduction would be permitted under 29 CFR 3.5 or 3.6 from an individual who is working on a project that is subject to 40 USC 276c.

(f) Paragraph (a) does not apply to any person who fails to provide any information to the department to assist the department in determining prevailing wage rates or prevailing hours of labor under sub. (3) or (4).

Jim Doyle
Governor
Roberta Gassman
Secretary
LeAnna Ware
Acting Division Administrator



State of Wisconsin
Department of Workforce Development

EQUAL RIGHTS DIVISION
201 East Washington Avenue, Room A300
P.O. Box 8928
Madison, WI 53708
Telephone: (608) 266-6860
Fax: (608) 267-4592
TTY: (608) 264-8752
<http://www.dwd.state.wi.us/>

DEPARTMENTAL ORDER

ROBERT SPOERL, ROADSIDE FACILITIES ENGINEER
WI DOT
P O BOX 7986
MADISON, WI 53707-7986

RE: MADISON - JANESVILLE ROAD (MADISON SWEF)
TOWN OF PLEASANT SPRINGS, DANE COUNTY, WI
Determination No. 200600292 Project No. 1002-02-72

The application which you filed or was filed on your behalf, by the person copied below, for a prevailing wage rate determination applicable to the above-referenced project has been received.

A survey was conducted to determine the prevailing wage rate for the trade(s) or occupation(s) needed to complete the project. The findings of the survey are set forth in the enclosed determination.

If you believe that the wage rate for any trade or occupation does not accurately reflect the prevailing wage rate in the city, village or town in which the project is located, you have the right to request the department to conduct an administrative review regarding such wage rate.

Your request must be made, in writing, within 30 days from the date indicated below and at least 10 days before the date a construction contract(s) is to be awarded or negotiated. Your request must also include wage rate information on at least three (3) similar projects located in the city, village or town where the proposed project is located on which some work was performed by the contested trade(s) or occupation(s) during the current survey period and which was previously considered by the department in issuing the enclosed determination. See s. DWD 290.10 of the Wisconsin Administrative Code and either s. 66.0903 (3)(br) or s. 103.49 (3)(c), Stats. for a complete explanation of the administrative review process.

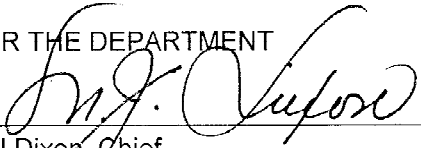
Now, therefore, it is hereby ORDERED that the prevailing wage rates set forth in the enclosed determination shall only be applicable to the above referenced project. This ORDER shall be deemed a FINAL ORDER of this department unless a timely request for an administrative review is filed with the department or a construction contract(s) is not awarded or negotiated before the determination's expiration date.

DATED

2/15/2006

Enclosures

FOR THE DEPARTMENT


M J Dixon, Chief
Labor Standards Bureau
Construction Wage Standards Section
(608) 266-0028

PREVAILING WAGE RATE DETERMINATION

Issued by the State of Wisconsin
Department of Workforce Development
Pursuant to s. 103.49, Stats.
Issued On: 2/15/2006

DETERMINATION NUMBER: 200600292

EXPIRATION DATE: Prime Contracts MUST Be Awarded Or Negotiated On Or Before 12/31/2006. If NOT, You MUST Reapply.

DESCRIPTION OF PROJECT: MADISON - JANESVILLE ROAD (MADISON SWEF)
PROJECT NO: 1002-02-72

LOCATION OF PROJECT: TOWN OF PLEASANT SPRINGS, DANE COUNTY, WI

CONTRACTING AGENCY: WI DOT

CLASSIFICATION: Contractors are required to call the Department of Workforce Development if there are any questions regarding the proper trade or classification to be used for any worker on a public works project.

OVERTIME: Time and one-half must be paid for all hours worked over 10 hours per day and 40 hours per calendar week and for all hours worked on Saturday, Sunday and the following six (6) 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.

FUTURE INCREASE: If indicated for a specific trade or occupation, the full amount of such increase MUST be added to the "TOTAL" indicated for such trade or occupation on the date(s) such increase(s) becomes effective.

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, whenever such pay is applicable.

SUBJOURNEY: Wage rates may be available for some of the classifications indicated below with the exception of laborers, truck drivers and heavy equipment operators. Any employer that desires to use any subjourney classification on this project MUST request the applicable wage rate from this department PRIOR to the date such classification is used on this project. Form ERD-10880 is available for this purpose.

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.

Fringe Benefits Must Be Paid On All Hours Worked			
TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY	HOURLY FRINGE BENEFITS	TOTAL
	\$	\$	\$
Acoustic Ceiling Tile Installer	24.91	11.36	36.27
Future Increase(s): Add \$1.35 on 5/28/06; Add \$1.35 on 5/27/07			
Boilermaker	27.64	15.17	42.81
Bricklayer, Blocklayer or Stonemason	27.36	12.26	39.62
Future Increase(s): Add \$1.60 6/5/2006; Add \$1.70 6/4/2007			
Cabinet Installer	24.91	11.36	36.27
Future Increase(s): Add \$1.35 on 5/28/06; Add \$1.35 on 5/27/07			
Carpenter	24.91	11.36	36.27
Future Increase(s): Add \$1.35 on 5/28/06; Add \$1.35 on 5/27/07			
Carpet Layer or Soft Floor Coverer	24.91	11.36	36.27

Fringe Benefits Must Be Paid On <u>All</u> Hours Worked			
<u>TRADE OR OCCUPATION</u>	<u>HOURLY BASIC RATE OF PAY</u>	<u>HOURLY FRINGE BENEFITS</u>	<u>TOTAL</u>
	\$	\$	\$
Future Increase(s): Add \$1.35 on 5/28/06; Add \$1.35 on 5/27/07			
Cement Finisher	25.66	10.58	36.24
Drywall Taper or Finisher	23.40	9.80	33.20
Future Increase(s): Add \$1.20 6/1/2006.			
Electrician	28.12	14.56	42.68
Future Increase(s): Add \$1.00 6/1/2006; Add \$.60 12/1/2006; Add \$1.00 6/1/2007; Add \$.65 12/1/2007			
Elevator Constructor	38.02	16.18	54.20
Fence Erector	18.75	3.50	22.25
Fire Sprinkler Fitter	31.29	12.40	43.69
Future Increase(s): Add \$.2.15 4/1/2006; Add \$.75 1/1/2007			
Glazier	31.60	5.39	36.99
Heat or Frost Insulator	28.88	12.94	41.82
Insulator (Batt or Blown)	20.47	9.25	29.72
Ironworker	27.05	13.71	40.76
Future Increase(s): Add \$1.65 6/1/2006; Add \$1.65 6/1/2007.			
Lather	24.31	10.61	34.92
Line Constructor (Electrical)	29.20	13.20	42.40
Marble Finisher	23.77	12.10	35.87
Future Increase(s): Add \$ 1.60 6/5/2006			
Marble Mason	29.71	12.10	41.81
Future Increase(s): Add \$ 1.60 6/5/2006			
Metal Building Erector	26.05	13.21	39.26
Millwright	26.51	11.36	37.87
Future Increase(s): Add \$1.35 on 5/28/06; Add \$1.35 on 5/27/07			
Overhead Door Installer	23.67	9.91	33.58
Painter	23.10	9.80	32.90
Future Increase(s): Add \$1.20 6/1/2006			
Premium Pay: Add \$.25 sandblasting; Add \$.30 drywall taping; Add \$.40 paperhanging; Add \$1.00 spray/structural steel.			
Pavement Marking Operator	23.46	9.45	32.91
Piledriver	25.41	11.36	36.77
Future Increase(s): Add \$1.35 on 5/28/06; Add \$1.35 on 5/27/07			
Pipeline Fuser or Welder (Gas or Utility)	17.45	1.79	19.24
Plasterer	24.64	7.39	32.03
Plumber	30.60	10.74	41.34
Future Increase(s): Add \$2.00 5/28/2006; Add \$2.00 6/3/2007; Add \$2.20 6/1/2008			
Refrigeration Mechanic	29.53	12.46	41.99
Roofer or Waterproofer	21.40	3.96	25.36
Sheet Metal Worker	28.03	14.77	42.80
Steamfitter	32.15	10.71	42.86
Future Increase(s): Add \$2.00 5/29/2006			
Teledata Technician or Installer	20.00	9.20	29.20
Future Increase(s): Add \$1.10 6/1/2006			
Temperature Control Installer	29.35	10.89	40.24
Terrazzo Finisher	15.02	0.83	15.85
Terrazzo Mechanic	25.89	7.57	33.46

Fringe Benefits Must Be Paid On All Hours Worked

TRADE OR OCCUPATION	HOURLY BASIC RATE OF PAY	HOURLY FRINGE BENEFITS	TOTAL
	\$	\$	\$
Tile Finisher	15.02	0.83	15.85
Tile Setter	25.89	7.57	33.46
Tuckpointer, Caulker or Cleaner	19.95	5.55	25.50
Underwater Diver (Except on Great Lakes)	24.81	10.61	35.42
Well Driller or Pump Installer	20.56	10.85	31.41
Siding Installer	26.71	14.34	41.05
Heavy Equipment Operator - ELECTRICAL LINE CONSTRUCTION ONLY	23.73	13.26	36.99
Light Equipment Operator -ELECTRICAL LINE CONSTRUCTION ONLY	28.50	9.95	38.45
Heavy Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	20.44	10.58	31.02
Light Truck Driver - ELECTRICAL LINE CONSTRUCTION ONLY	18.98	9.97	28.95
Groundman - ELECTRICAL LINE CONSTRUCTION ONLY	19.92	9.17	29.09

TRUCK DRIVERS

Single Axle or Two Axle	20.85	12.26	33.11
Future Increase(s): Add \$.80 on 5/1/06; Add \$1.45 5/1/2007; Add \$1.45 5/1/2008; Add \$1.65 5/1/2009; Add \$1.65 5/ 1/ 10			
Three or More Axle	18.45	8.92	27.37
Articulated, Euclid, Dumptr, Off Road Material Hauler	26.92	14.00	40.92
Future Increase(s): Add \$1.55 6/1/06; Add \$1.60 6/1/07			
Pavement Marking Vehicle	19.47	7.52	26.99
Truck Mechanic	19.60	12.01	31.61

LABORERS

General Laborer	20.54	9.75	30.29
Future Increase(s): Add \$1.25 6/5/2006; Add \$1.30 6/7/2007 Premium Pay: Add \$1.00/hr for certified welder; Add \$.25/hr for mason tender			
Asbestos Abatement Worker	15.88	3.65	19.53
Landscaper	16.77	0.00	16.77
Gas or Utility Pipeline Laborer (Other Than Sewer and Water)	21.15	9.29	30.44
Fiber Optic Laborer (Outside, Other Than Concrete Encased)	18.71	1.69	20.40
Railroad Track Laborer	12.31	1.46	13.77

**HEAVY EQUIPMENT OPERATORS
SITE PREPARATION, UTILITY AND LANDSCAPING WORK ONLY**

Crane; Backhoe (Track Type); Tractor or Truck Mounted Hydraulic Backhoe; Gradall (Cruz-Aire Type); Mechanic or Welder; Bulldozer or Endloader; Grader or Motor Patrol; Scraper (Self Propelled or Tractor Drawn) 5cu yards or more capacity; Power Subgrader; Asphalt Milling Machine; Boring Machine (Horizontal, Vertical or Directional); Air Track, Rotary or Percussion Drilling Machine; Trencher; Post Hole Digger or Driver; Tug or Launch (not performing work on the Great Lakes)	26.96	13.80	40.76
Farm or Industrial Type Tractor; Greaser; Compactor (Self-Propelled); Broom or Sweeper; Environmental Burner	26.92	14.00	40.92
Future Increase(s): Add \$1.55 on 6/1/06; Add \$1.60 on 6/1/07			

Fringe Benefits Must Be Paid On All Hours Worked

<u>TRADE OR OCCUPATION</u>	<u>HOURLY BASIC RATE OF PAY</u>	<u>HOURLY FRINGE BENEFITS</u>	<u>TOTAL</u>
	<u>\$</u>	<u>\$</u>	<u>\$</u>
Crusher, Screening or Wash Plant; Air Compressor (400 CFM or Over); Pump (3 Inch or Over) or Well Points; Refrigeration Plant or Freeze Machine; Skid Steer Loader (With or Without Attachments); Skid Rig; Stump Chipper; Mulcher; Vibratory Hammer or Extractor Future Increase(s): Add \$1.55 6/5/2006; Add \$1.60 6/6/2007	24.72	14.65	39.37

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

Crane, Tower Crane or Derrick, With or Without Attachments, With a Lifting Capacity of Over 100 Tons; Crane, Tower Crane or Derrick, With Boom, Leads and/or Jib Lengths Measuring 176 Feet or Over Future Increase(s): Add \$2.05 6/5/2006; Add \$1.60 6/6/2007 Premium Pay: Add \$.50/hr for cranes with lifting capacity over 200 ton; Add \$1.00/hr. at 300 ton; Add \$1.50/hr at 400 ton; Add \$2.00/hr at 500 ton.	28.32	14.65	42.97
Crane, Tower Crane or Derrick, With or Without Attachments, With a Lifting Capacity of 100 Tons or Under; Crane, Tower Crane or Derrick, With Boom, Leads and/or Jib Lengths Measuring 175 Feet or Under; Backhoe (Track Type) Having a Mfg.'s Rated Capacity of 130,000 Lbs. or Over; Traveling Crane (Bridge Type); Caisson Rig; Pile Driver; Dredge (Not Performing Work on the Great Lakes) Future Increase(s): Add \$1.55 6/5/2006; In addition add \$.25/hr for cranes with lifting capacity of 45 ton or over; Add \$1.60 6/6/2007	27.82	14.65	42.47
Crane (Go-Devil Type) or Truck Mounted Hydraulic Crane (10 Tons or Under); Backhoe (Track Type) Having a Mfg.'s Rated Capacity of Under 130,000 Lbs.; Tractor or Truck Mounted Hydraulic Backhoe; Gradall (Cruz-Aire Type); Mechanic or Welder; Bulldozer or Endloader; Grader or Motor Patrol; Scraper (Self Propelled or Tractor Drawn) 5 cu yards or more capacity; Concrete Pump, Grout Pump or Concrete Conveyor (Rotec or Bidwell Type); Concrete Breaker (Manual or Remote); Concrete Batch Plant; Power Subgrader; Concrete Spreader; Concrete Paver; Concrete Grinder or Planing Machine; Concrete Conveyor System; Concrete Slipform Placer; Curb and Gutter Machine; Roller (Over 5 Ton); Shouldering Machine; Boring Machine (Horizontal, Vertical or Directional); Air Track, Rotary or Percussion Drilling Machine; Straddle Carrier or Travel Lift; Forklift (Machinery Moving or Steel Erection); Manhoist or Elevator; Material or Stack Hoist; Trencher; Sideboom; Hydro-Blaster (10,000 PSI or Over); Post Hole Digger or Driver; Railroad Track Rail Leveling Machine, Tie Placer, Extractor, Tamper, Stone Leveler or Rehabilitation Equipment	28.50	9.95	38.45
Farm or Industrial Type Tractor; Greaser; Compactor (Self-Propelled); Concrete Saw (Vermeer Type); Concrete Bump Cutter or Grooving Machine; Tining or Curing Machine; Roller (5 Tons or Under); Broom or Sweeper; Hoist (Tugger); Environmental Burner	20.52	11.87	32.39
Crusher, Screening or Wash Plant; Air, Electric or Hydraulic Jacking System; Air Compressor (400 CFM or Over); Generator (150 KW or Over); Pump (3 Inch or Over) or Well Points; Refrigeration Plant or Freeze Machine; Skid Steer Loader (With or Without Attachments); Robotic Tool Carrier (With or Without Attachments); Skid Rig; Stump Chipper; Mulcher; Vibratory Hammer or Extractor	23.73	13.26	36.99
Oiler; Forklift	21.65	5.55	27.20
Gas or Utility Pipeline, Except Sewer and Water (Primary Equipment)	28.34	12.98	41.32

Fringe Benefits Must Be Paid On <u>All</u> Hours Worked			
<u>TRADE OR OCCUPATION</u>	<u>HOURLY BASIC RATE OF PAY</u>	<u>HOURLY FRINGE BENEFITS</u>	<u>TOTAL</u>
	\$	\$	\$
Gas or Utility Pipeline, Except Sewer and Water (Secondary Equipment)	28.34	12.98	41.32
Fiber Optic Cable Equipment	29.15	12.90	42.05

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 most 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) 266-0028.

The following statutory provisions apply to state building public works projects and are set forth below pursuant to the requirements of s. 103.49 (3)(a), Stats.

(2) **PREVAILING WAGE RATES AND HOURS OF LABOR.** Any contract hereafter made for the erection, construction, remodeling, repairing or demolition of any project of public works, except contracts for the construction or maintenance of public highways, streets and bridges, to which the state, any state agency or the University of Wisconsin Hospitals and Clinics Authority is a party shall contain a stipulation that no person described in sub. (2m) may be permitted to work a greater number of hours per day or per calendar week than the prevailing hours of labor determined under sub. (3), except that any such person may be permitted or required to work more than such prevailing hours of labor per day and per calendar week if he or she is paid for all hours worked in excess of the prevailing hours of labor at a rate of at least 1.5 times his or her hourly basic rate of pay; nor may he or she be paid less than the prevailing wage rate in the same or most similar trade or occupation in the area wherein such project of public works is situated determined under sub. (3). A reference to the prevailing wage rates and prevailing hours of labor determined under sub. (3) shall be published in the notice issued for the purpose of securing bids for the project. If any contract or subcontract for a project that is subject to this section is entered into, the prevailing wage rates and prevailing hours of labor determined under sub. (3) shall be physically incorporated into and made part of the contract or subcontract, except that for a minor subcontract, as determined by the department, the department shall prescribe by rule the method of notifying the minor subcontractor of the prevailing wage rates and prevailing hours of labor applicable to the minor subcontract. The prevailing wage rates and prevailing hours of labor applicable to a contract or subcontract may not be changed during the time that the contract or subcontract is in force.

(6m) **LIABILITY AND PENALTIES.** (a) Except as provided in pars. (b), (d) and (f), any contractor, subcontractor or agent thereof who violates this section may be fined not more than \$200 or imprisoned for not more than 6 months or both. Each day that any such violation continues shall be considered a separate offense.

(b) Whoever induces any individual who seeks to be or is employed on any project that is subject to this section to give up, waive or return any part of the wages to which the individual is entitled under the contract governing such project, or who reduces the hourly basic rate of pay normally paid to an employee for work on a project that is not subject to this section during a week in which the employee works both on a project that is subject to this section and on a project that is not subject to this section, by threat not to employ, by threat of dismissal from such employment or by any other means is guilty of an offense under s. 946.15 (1).

(c) Any person employed on a project that is subject to this section who knowingly permits a contractor, subcontractor or agent thereof to pay him or her less than the prevailing wage rate set forth in the contract governing such project, who gives up, waives or returns any part of the compensation to which he or she is entitled under the contract, or who gives up, waives or returns any part of the compensation to which he or she is normally entitled for work on a project that is not subject to this section during a week in which the person works both on a project that is subject to this section and on a project that is not subject to this section, is guilty of an offense under s. 946.15 (2).

(d) Whoever induces any individual who seeks to be or is employed on any project that is subject to this section to permit any part of the wages to which the individual is entitled under the contract governing such project to be deducted from the individual's pay is guilty of an offense under s. 946.15 (3), unless the deduction would be permitted under 29 CFR 3.5 or 3.6 from an individual who is working on a project that is subject to 40 USC 276c.

(e) Any person employed on a project that is subject to this section who knowingly permits any part of the wages to which he or she is entitled under the contract governing such project to be deducted from his or her pay is guilty of an offense under s. 946.15 (4), unless the deduction would be permitted under 29 CFR 3.5 or 3.6 from a person who is working on a project that is subject to 40 USC 276c.

(f) Paragraph (a) does not apply to any person who fails to provide any information to the department to assist the department in determining prevailing wage rates and prevailing hours of labor under sub. (3) (a) or (am).

SUPERSEDES DECISION W1020010
U. S. DEPARTMENT OF LABOR
(DAVIS-BACON ACT, MINIMUM WAGE RATES)

STATE: Wisconsin
DECISION NUMBER: W120030010
DESCRIPTION OF WORK: Highways and Airport Runway and Taxiway Construction

DATE: April 7, 2006

LABORERS CLASSIFICATION:

Group 1: General Laborer; Tree Trimmer; Conduit Layer; Demolition and Wrecking Laborer; Guard Rail, Fence and Bridge Builder; Landscafer, Multiplate Culvert Assembler; Stone Handler; Bituminous Worker (Shoveler, Loader, Utility Man); Batch Truck Dumper; or Cement Handler; Bituminous Worker; (Dumper, Ironer, Smoother, Tamper); Concrete Handler		Basic Hourly Rates		Fringe Benefits	
Group 2: Air Tool Operator; Joint Sawyer and Filler (Pavement); Vibrator or Tamper Operator (Mechanical Hand Operated); Chain Saw Operator; Demolition Burning Torch Laborer		\$20.98		9.17	
Group 3: Bituminous Worker (Raker and Lutenan); Formsetter (Curb, Sidewalk, and Pavement); Strike Off man		21.13		9.17	
Group 4: Line and Grade Specialist		21.33		9.17	
Group 5: Blaster and Powderman		21.18		9.17	
Group 6: Flagperson and Traffic Control Person		17.33		9.17	

Truck Drivers:

1 & 2 Axles	20.85	12.26
Three or More Axles; Euclids, Dumptor & Articulated, Truck Mechanic	21.00	12.26

CLASSES OF LABORER AND MECHANICS

Bricklayer	27.36	12.26
Carpenter	24.31	10.43
Millwright	25.91	10.43
Piledriverman	24.81	10.43
Ironworker	26.05	13.24
Cement Mason	25.17	11.33
Electrician	See Page 3	
Line Construction		
Lineman	30.22	4.50 + 28.75%
Heavy Equipment Operator	27.20	4.50 + 28.75%
Equipment Operator	24.18	4.50 + 28.75%
Heavy Groundman Driver	21.15	4.50 + 28.75%
Light Groundman Driver	19.64	4.50 + 28.75%
Groundman	16.62	4.50 + 28.75%
Painter, Brush	23.10	9.80
Painter, Spray, Structural Steel , Bridges	24.10	9.80
Well Drilling:		
Well Driller	16.52	3.70

Notes: Welders receive rate prescribed for craft performing operation to which welding is incidental. 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 (29 CFR, 5.5(a)(1)(ii)). Includes Modification 0, dated June 13, 2003; Modification 1, dated March 19, 2004; Modification 2, dated June 25, 2004; Modification 3, dated July 23, 2004; Modification 4, dated November 26, 2004; Modification 5, dated July 8, 2005; Modification 6, dated Sept. 9, 2005; Modification 7, dated Dec. 2, 2005; Modification 8, dated Jan. 20, 2006; Modification 9, dated Jan. 27, 2006; Modification 10, dated March 3, 2006; Modification 11, dated April 7, 2006;

SUPERSEDES DECISION W1020010
U. S. DEPARTMENT OF LABOR
(DAVIS-BACON ACT, MINIMUM WAGE RATES)

STATE: Wisconsin
DECISION NUMBER: W120030010
DESCRIPTION OF WORK: Highways and Airport Runway and Taxiway Construction

DATE: April 7, 2006

POWER EQUIPMENT OPERATORS CLASSIFICATION:		Basic Hourly Rates	Fringe Benefits	POWER EQUIPMENT OPERATORS CLASSIFICATION: (Continued)		Basic Hourly Rates	Fringe Benefits
Group 1:	Cranes, tower cranes and derricks, with or without attachments, with a lifting capacity of over 100 tons or cranes, tower cranes and derricks with boom, leads and/or jib lengths measuring 176 feet or longer	\$28.27	\$14.48		(scraper, dozer, pusher, loader); scraper - rubber tired (single or twin engine); endloader hydraulic backhoe (tractor-type); trenching machine; skid rigs; tractor, side boom (heavy); drilling or boring machine (mechanical heavy); roller (over 5 tons); percussion or rotary drilling machine; air track; blaster; loading machine (conveyor); tugger; boatmen; winches and A-frames; post driver; material hoist operator.	\$27.27	\$14.48
Group 2:	Cranes, tower cranes and derricks, with or without attachments, with a lifting capacity of 100 tons or less or cranes, tower cranes and derricks with boom, leads and/or jib lengths measuring 175 feet or less, and backhoes (excavators) having a manufacturer's rated capacity of 3 cu. yds. and over, caisson rigs, pile driver, dredge operator, dredge engineer.....	\$27.77	\$14.48	Group 4:	Greaser, roller steel (5 tons or less); roller (pneumatic tired) - self-propelled; tractor (mounted or towed compactors and light equipment); shouldering machine; self-propelled chip spreader; concrete spreader; finishing machine; mechanical float; curing machine; power subgrader; joint saw (multiple blade) belting machine; burlap machine; texturing machine; tractor, endloader (rubber tired) - light; jeep digger; fork lift; mulcher; launch operator; fireman; environmental burner.	\$27.01	\$14.48
Group 3:	Mechanic or welder - heavy duty equipment, cranes with a lifting capacity of 25 tons or less, concrete breaker (manual or remote); vibrator/sonic concrete breaker; concrete laser screed; concrete slipform paver; concrete batch plant operator; concrete pavement spreader - heavy duty (rubber tired); concrete spreader and distributor, automatic subgrader (concrete); concrete grinder and planing machine; concrete slipform curb and gutter machine; slipform concrete placer; tube finisher; hydro blaster (10,000 psi and over); bridge paver; concrete conveyor system; concrete pump; stabilizing mixer (self propelled); shoulder widener; asphalt plant engineer; bituminous paver; bump cutter and grooving machine; milling machine; screed (bituminous paver); asphalt heater, planer and scarifier; backhoes (excavators) having a manufacturers rated capacity of under 3 cu. yds.; grader or motor patrol; tractor			Group 5:	Air compressor; power pack; vibratory hammer and extractor; heavy equipment, leadman; tank car heaters; stump chipper; curb machine operator; concrete proportioning plants generators; mudjack operator; rock breaker; crusher or screening plant; screed (milling machine); automatic belt conveyor and surge bin; pug mill operator; oiler; pump (over 3 inches); drilling machine helper.....	\$26.72	\$14.48
				Group 6:	Off – road material hauler with or without ejector	\$20.82	\$14.48
				Premium Pay: EPA Level “A” protection - \$ 3.00 per hour EPA Level “B” protection - \$ 2.00 per hour EPA Level “C” protection - \$ 1.00 per hour			

SUPERSEDES DECISION W1020010
U. S. DEPARTMENT OF LABOR
(DAVIS-BACON ACT, MINIMUM WAGE RATES)

STATE: Wisconsin
DECISION NUMBER: W120030010
DESCRIPTION OF WORK: Highways and Airport Runway and Taxiway Construction
LABORERS CLASSIFICATION:

DATE: April 7, 2006

		Rates	Benefits	
Electricians				Area 4 -
Area 1	.....	\$25.15	12.36	BROWN, DOOR, KEWAUNEE, MANITOWOC (except Schleswig), MARINETTE (Wausauke and area south thereof), OCONTO, MENOMINEE (East of a line 6 miles West of the West boundary of Oconto County), SHAWANO (except area North of Townships of Aniwa and Hutchins) COUNTIES.
Area 2:	Electricians.....			Area 5 -
Area 3:	.....	26.80	27.8%+6.60	ADAMS, CLARK (Colby, Freemont, Lynn, Mayville, Sherman, Sherwood, Unity), FOREST, JUNEAU, LANGLADE, LINCOLN, MARATHON, MARINETTE (Area North of the town of Wausauke), MENOMINEE (Area West of a line 6 miles West of the West boundary of Oconto County), ONEIDA, PORTAGE, SHAWANO (Area North of the townships of Aniwa and Hutchins), VILAS AND WOOD COUNTIES
Area 4:	Electrical contracts under \$90,000	23.74	12.13	
Area 5	Electrical contracts over \$90,000	25.93	12.20	
Area 6	.....	26.25	26.75%+6.75	
	.....	25.00	12.16	
	.....	29.54	24.8%+6.05	Area 6 -
Area 8	.....			KENOSHA COUNTY
Area 9:	Electricians.....	27.50	13.72	DODGE, (Emmet Township only), GREEN, JEFFERSON, LAFAYETTE, RACINE (Burlington township), ROCK and WALWORTH COUNTIES
Area 10	Electricians.....	28.12	28%+6.71	
Area 11	.....	24.70	15.46	COLUMBIA, DANE, DODGE, (area west of Hwy. 26, except Chester & Emmet Townships), GREEN LAKE (except townships of Berlin, Seneca and St. Marie), IOWA, MARQUETTE (except townships of Neshkoka, Crystal Lake, Newton and Springfield), and SAUK COUNTIES
Area 12	.....	27.42	54.5%	
Area 13	.....	29.67	14.26	
	.....	28.17	16.63	Area 10 -
Teledata System Installer				CALUMET (township of New Holstein), FOND DU LAC, (except. Waupun), MANITOWOC (Schleswig), and SHEBOYGAN COUNTIES
Area 14	.....			Area 11 -
Installer/Technician		20.00	18.2%+5.75	DOUGLAS COUNTY
Sound & Communications				Area 12 -
Area 15	.....			RACINE (except Burlington township) COUNTY
Installer		14.98	10.97	Area 13 -
Technician.....		21.98	11.99	MILWAUKEE, OZAUKEE, WASHINGTON and WAUKESHA COUNTIES
Area 1 -	CALUMET (except township of New Holstein), GREEN LAKE (N. part, including Townships of Berlin, St. Marie and Seneca), MARQUETTE (N. part, including Townships of Crystal Lake, Neshkoro, Newton & Springfield), OUTAGAMIE, WAUPACA, WAUSHARA and WINNEBAGO			Area 14 -
Area 2 -	ASHLAND, BARRON, BAYFIELD, BUFFALO, BURNETT, CHIPPEWA, CLARK (except Mayville, Colby, Unity, Sherman, Fremont, Lynn and Sherwood), CRAWFORD, DUNN, EAU CLAIRE, GRANT, IRON, JACKSON, LA CROSSE, MONROE, PEPIN, PIERCE, POLK, PRICE, RICHLAND, RUSK, ST. CROIX, SAWYER, TAYLOR, TREMPLEALEAU, VERNON and WASHBURN COUNTIES			Area 15 -
Area 3 -	FLORENCE (townships of Aurora, Commonwealth, Fern, Florence and Homestead), MARINETTE (Niagara township)			DODGE (East of Hwy. 26, including Chester Twp, excluding Emmet Twp), FOND DU LAC (Except Waupun), MILWAUKEE, OZAUKEE, MANITOWOC (Schleswig), AND WAUKESHA COUNTIES.

GENERAL DECISION: **WI20030005** 03/03/2006 WI5

Date: March 3, 2006

General Decision Number: **WI20030005** 03/03/2006

Superseded General Decision Number: WI020005

State: Wisconsin

Construction Type: Building

County: Dane County 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	06/13/2003
1	03/12/2004
2	06/25/2004
3	07/30/2004
4	11/26/2004
5	06/17/2005
6	07/08/2005
7	07/29/2005
8	09/09/2005
9	12/02/2005
10	03/03/2006

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 07/01/2005

	Rates	Fringes
Boilermaker		
Boilermaker.....	\$ 28.64	16.33
Small Boiler Repair (under 25,000 lbs/hr).....	\$ 22.91	11.81

* BRWI0013-001 06/01/2005

Rates	Fringes

Bricklayer.....	\$ 27.36	12.26
Terrazzo Worker Mechanic.....	\$ 29.15	11.62
Tile & Terrazzo Finisher		
Tile Finisher.....	\$ 20.52	11.62
Terrazzo Finsiher.....	\$ 23.32	11.62
Tile Layer.....	\$ 25.65	11.62

CARP0252-007 06/01/2004

	Rates	Fringes
Carpenter & Soft Floor Layer (Including Acoustical work and Drywall hanging; Excluding Batt Insulation).....	\$ 24.31	10.43
Mil		

FEBRUARY 1999

**NOTICE TO BIDDERS
WAGE RATE DECISION**

The wage rate decision of the Secretary of Labor which has been incorporated in these advertised specifications is incomplete in that the classifications may be omitted from the Secretary of Labor's decision.

Since the bidder is responsible, independently, for ascertaining area practice with respect to the necessity, or lack of necessity, for the use of these classifications in the prosecution of the work contemplated by this project, no inference may be drawn from the omission of these classifications concerning prevailing area practices relative to their use. Further, this omission will not, per se, be construed as establishing any governmental liability for increased labor cost if it is subsequently determined that such classifications are required.

There may be omissions and/or errors in the federal wage rates. The bidder is responsible for evaluating and determining the correct applicable rate. The higher of state or federal rate will apply.

SCHEDULE OF ITEMS

REVISED:

CONTRACT:
20060613001PROJECT(S):
1002-02-72FEDERAL ID(S):
IM 2006336

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS

SECTION 0001 ROADWAY ITEMS

0010	201.0120 CLEARING	32.000				
		ID	.		.	
0020	201.0220 GRUBBING	32.000				
		ID	.		.	
0030	204.0100 REMOVING PAVEMENT	9,457.000				
		SY	.		.	
0040	204.0110 REMOVING ASPHALTIC SURFACE	800.000				
		SY	.		.	
0050	204.0155 REMOVING CONCRETE SIDEWALK	49.000				
		SY	.		.	
0060	204.0180 REMOVING MARKER POSTS	28.000				
		EACH	.		.	
0070	204.0190 REMOVING SURFACE DRAINS	1.000				
		EACH	.		.	
0080	204.0195 REMOVING CONCRETE BASES	1.000				
		EACH	.		.	
0090	204.0205 REMOVING UTILITY POLES	11.000				
		EACH	.		.	
0100	204.0220 REMOVING INLETS	2.000				
		EACH	.		.	

SCHEDULE OF ITEMS

REVISED:

CONTRACT:
20060613001PROJECT(S):
1002-02-72FEDERAL ID(S):
IM 2006336

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0110	204.0230 REMOVING BUILDING (STATION) 01. 351'R'+00	LUMP	LUMP			.
0120	204.9060.S REMOVING (ITEM DESCRIPTION) 01. PULL BOXES	1.000 EACH		.		.
0130	205.0100 EXCAVATION COMMON	5,000.000 CY		.		.
0140	211.0200 PREPARE FOUNDATION FOR CONCRETE PAVEMENT (PROJECT) 01. 1002-02-72	LUMP	LUMP			.
0150	213.0100 FINISHING ROADWAY (PROJECT) 01. 1002-02-72	1.000 EACH		.		.
0160	301.0100.S QMP BASE AGGREGATE	4,150.000 TON		.		.
0170	305.0110 BASE AGGREGATE DENSE 3/4-INCH	4,150.000 TON		.		.
0180	415.0110 CONCRETE PAVEMENT 11-INCH	11,975.000 SY		.		.
0190	415.1150.S CONCRETE PAVEMENT FAST TRACK (INCH) 01. 11-INCH	1,397.000 SY		.		.
0200	415.2000.S INCENTIVE STRENGTH CONCRETE PAVEMENT	2,750.000 DOL	1.00000		2750.00	
0210	415.3000.S QMP CONCRETE PAVEMENT	10.000 DAY		.		.

SCHEDULE OF ITEMS

REVISED:

CONTRACT:
20060613001PROJECT(S):
1002-02-72FEDERAL ID(S):
IM 2006336

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0220	415.5105 CONCRETE PAVEMENT CONTINUOUS REINFORCEMENT	871.000 SY	.		.	
0230	416.0050 CONCRETE PAVEMENT APPROACH SLAB	67.000 SY	.		.	
0240	416.0160 CONCRETE DRIVEWAY 6-INCH	48.000 SY	.		.	
0250	416.0610 PAVEMENT TIES	18.000 EACH	.		.	
0260	416.0620 PAVEMENT DOWEL BARS	258.000 EACH	.		.	
0270	416.1010 CONCRETE SURFACE DRAINS	6.000 CY	.		.	
0280	455.0105 ASPHALTIC MATERIAL PG58-28	32.000 TON	.		.	
0290	455.0605 TACK COAT	45.000 GAL	.		.	
0300	460.1100 HMA PAVEMENT TYPE E-0.3	532.000 TON	.		.	
0310	460.2000 INCENTIVE DENSITY HMA PAVEMENT	350.000 DOL	1.00000		350.00	
0320	460.3000 QMP HMA MIXTURE	532.000 TON	.		.	

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LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0330	532.0200.S WALL MODULAR BLOCK GRAVITY	144.000 SF	.		.	
0340	602.0410 CONCRETE SIDEWALK 5-INCH	2,180.000 SF	.		.	
0350	602.0505 CURB RAMP DETECTABLE WARNING FIELD YELLOW	16.000 SF	.		.	
0360	602.1500 CONCRETE STEPS	130.000 SF	.		.	
0370	606.0200 RIPRAP MEDIUM	4.000 CY	.		.	
0380	608.0315 STORM SEWER PIPE REINFORCED CONCRETE CLASS III 15-INCH	70.000 LF	.		.	
0390	611.0303 INLETS TYPE 3	4.000 EACH	.		.	
0400	611.0639 INLET COVERS TYPE H-S	4.000 EACH	.		.	
0410	614.0305 STEEL PLATE BEAM GUARD CLASS A	424.000 LF	.		.	
0420	614.0370 STEEL PLATE BEAM GUARD ENERGY ABSORBING TERMINAL	2.000 EACH	.		.	
0430	618.0100 MAINTENANCE AND REPAIR OF HAUL ROADS (PROJECT) 01. 1002-02-72	1.000 EACH	.		.	

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			DOLLARS	CTS	DOLLARS	CTS
0440	619.1000 MOBILIZATION	1.000				
	EACH		.		.	
0450	624.0100 WATER	17.000				
	MGAL		.		.	
0460	625.0500 SALVAGED TOPSOIL	10,600.000				
	SY		.		.	
0470	627.0200 MULCHING	9,800.000				
	SY		.		.	
0480	628.1504 SILT FENCE	1,300.000				
	LF		.		.	
0490	628.1520 SILT FENCE MAINTENANCE	1,300.000				
	LF		.		.	
0500	628.1905 MOBILIZATIONS EROSION CONTROL	1.000				
	EACH		.		.	
0510	628.1910 MOBILIZATIONS EMERGENCY EROSION CONTROL	3.000				
	EACH		.		.	
0520	628.7005 INLET PROTECTION TYPE A	5.000				
	EACH		.		.	
0530	629.0210 FERTILIZER TYPE B	7.000				
	CWT		.		.	
0540	630.0130 SEEDING MIXTURE NO. 30	190.000				
	LB		.		.	

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			DOLLARS	CTS	DOLLARS	CTS
0550	630.0140 SEEDING MIXTURE NO. 40	14.000 LB	.		.	
0560	631.1000 SOD LAWN	730.000 SY	.		.	
0570	631.1100 SOD EROSION CONTROL	180.000 SY	.		.	
0580	632.0101 TREES (SPECIES, ROOT, SIZE) 01. SCARLET SENTINEL HYBRID MAPLE, 2 1/2-INCH CAL B&B	1.000 EACH	.		.	
0590	632.0201 SHRUBS (SPECIES, ROOT, SIZE) 01. GRO-LOW FRAGRANT SUMAC, 18-INCH HGT CONT	46.000 EACH	.		.	
0600	632.0201 SHRUBS (SPECIES, ROOT, SIZE) 02. NEON FLASH SPIREA, 18-INCH HGT CONT	7.000 EACH	.		.	
0610	632.0201 SHRUBS (SPECIES, ROOT, SIZE) 03. MOHICAN VIBURNUM, 24-INCH HGT CONT	6.000 EACH	.		.	
0620	632.0201 SHRUBS (SPECIES, ROOT, SIZE) 04. GOLD COAST CHINESE JUNIPER, 24-INCH SPD CONT	47.000 EACH	.		.	
0630	632.0201 SHRUBS (SPECIES, ROOT, SIZE) 05. ANDORRA COMPACT JUNIPER, 24-INCH SPD CONT	31.000 EACH	.		.	

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			DOLLARS	CTS	DOLLARS	CTS
0640	632.9101 LANDSCAPE PLANTING SURVEILLANCE AND CARE CYCLES	148.000 EACH	.		.	
0650	633.0100 DELINEATOR POSTS STEEL	71.000 EACH	.		.	
0660	633.0500 DELINEATORS	90.000 EACH	.		.	
0670	634.0614 POSTS WOOD 4X6-INCH X 14-FT	21.000 EACH	.		.	
0680	635.0200 SIGN SUPPORTS STRUCTURAL STEEL HS	550.000 LB	.		.	
0690	636.0100 SIGN SUPPORTS CONCRETE MASONRY	1.200 CY	.		.	
0700	636.1000 SIGN SUPPORTS STEEL REINFORCEMENT HS	68.000 LB	.		.	
0710	637.0101 SIGNS TYPE I	174.000 SF	.		.	
0720	637.0202 SIGNS REFLECTIVE TYPE II	142.000 SF	.		.	
0730	638.2601 REMOVING SIGNS TYPE I	2.000 EACH	.		.	
0740	638.2602 REMOVING SIGNS TYPE II	9.000 EACH	.		.	

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			DOLLARS	CTS	DOLLARS	CTS
0750	638.3000 REMOVING SMALL SIGN SUPPORTS	9.000 EACH	.		.	
0760	642.5200 FIELD OFFICE TYPE C (PROJECT) 01. 1002-02-72	1.000 EACH	.		.	
0770	643.0100 TRAFFIC CONTROL (PROJECT) 01. 1002-02-72	1.000 EACH	.		.	
0780	643.0300 TRAFFIC CONTROL DRUMS	15,940.000 DAYS	.		.	
0790	643.0420 TRAFFIC CONTROL BARRICADES TYPE III	1,150.000 DAYS	.		.	
0800	643.0705 TRAFFIC CONTROL WARNING LIGHTS TYPE A	2,290.000 DAYS	.		.	
0810	643.0715 TRAFFIC CONTROL WARNING LIGHTS TYPE C	160.000 DAYS	.		.	
0820	643.0800 TRAFFIC CONTROL ARROW BOARDS	20.000 DAYS	.		.	
0830	643.0900 TRAFFIC CONTROL SIGNS	2,175.000 DAYS	.		.	
0840	643.0905.S TRAFFIC CONTROL COVERING SIGNS	2.000 EACH	.		.	
0850	643.1050.S TRAFFIC CONTROL SIGNS PORTABLE CHANGEABLE MESSAGE	50.000 DAY	.		.	

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			DOLLARS	CTS	DOLLARS	CTS
0860	645.0130 GEOTEXTILE FABRIC TYPE R	42.000 SY	.		.	
0870	646.0106 PAVEMENT MARKING EPOXY 4-INCH	7,500.000 LF	.		.	
0880	647.0256 PAVEMENT MARKING SYMBOLS EPOXY	5.000 EACH	.		.	
0890	647.0566 PAVEMENT MARKING STOP LINE EPOXY 18-INCH	30.000 LF	.		.	
0900	647.0656 PAVEMENT MARKING PARKING STALL EPOXY	1,575.000 LF	.		.	
0910	647.0766 PAVEMENT MARKING CROSSWALK EPOXY 6-INCH	200.000 LF	.		.	
0920	650.4000 CONSTRUCTION STAKING STORM SEWER SYSTEM	2.000 EACH	.		.	
0930	650.7000 CONSTRUCTION STAKING CONCRETE PAVEMENT	2,953.000 LF	.		.	
0940	650.8500 CONSTRUCTION STAKING ELECTRICAL INSTALLATIONS (PROJECT) 01. 1002-02-72	LUMP	LUMP		.	
0950	652.0225 CONDUIT RIGID NONMETALLIC SCHEDULE 40 2-INCH	3,625.000 LF	.		.	

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			DOLLARS	CTS	DOLLARS	CTS
0960	652.0235 CONDUIT RIGID NONMETALLIC SCHEDULE 40 3-INCH	320.000 LF	.		.	
0970	653.0140 PULL BOXES STEEL 24X42-INCH	8.000 EACH	.		.	
0980	654.0105 CONCRETE BASES TYPE 5	27.000 EACH	.		.	
0990	654.0215 CONCRETE CONTROL CABINET BASES TYPE 9	1.000 EACH	.		.	
1000	655.0610 ELECTRICAL WIRE LIGHTING 12 AWG	4,050.000 LF	.		.	
1010	655.0620 ELECTRICAL WIRE LIGHTING 8 AWG	20,030.000 LF	.		.	
1020	657.0255 TRANSFORMER BASES STANDARD 11 1/2-INCH BOLT CIRCLE	27.000 EACH	.		.	
1030	657.0320 POLES TYPE 5	27.000 EACH	.		.	
1040	657.0705 LUMINAIRE ARMS TRUSS TYPE 4 1/2-INCH CLAMP 10-FT	13.000 EACH	.		.	
1050	657.0715 LUMINAIRE ARMS TRUSS TYPE 4 1/2-INCH CLAMP 15-FT	14.000 EACH	.		.	
1060	659.0115 LUMINAIRES UTILITY HPS 150 WATTS	27.000 EACH	.		.	

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			DOLLARS	CTS	DOLLARS	CTS
1070	690.0100 SAWING EXISTING PAVEMENT	48.000 LF	.		.	
1080	690.0200 SAWING CONCRETE PAVEMENT FULL DEPTH	338.000 LF	.		.	
1090	SPV.0060 SPECIAL 01. BENCHES	1.000 EACH	.		.	
1100	SPV.0060 SPECIAL 02. FLAG POLES	1.000 EACH	.		.	
1110	SPV.0060 SPECIAL 03. FLOOD LIGHT 175-WATT MH WITH MOUNTING	1.000 EACH	.		.	
1120	SPV.0060 SPECIAL 04. TRASH RECEPTACLES	1.000 EACH	.		.	
1130	SPV.0060 SPECIAL 05. PERENNIALS: GOLDSTRUM BLACK-EYED SUSAN, #2 CONT	11.000 EACH	.		.	
1140	SPV.0090 SPECIAL 01. CONCRETE CURB & GUTTER 36-INCH TYPE A SPECIAL	2,150.000 LF	.		.	
1150	SPV.0105 SPECIAL 01. REMOVING WEIGHT SCALE & PIT	LUMP	LUMP		.	
1160	SPV.0105 SPECIAL 02. REMOVING UNDERGROUND LP TANK	LUMP	LUMP		.	

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			DOLLARS	CTS	DOLLARS	CTS
1170	SPV.0105 SPECIAL 03. WELL CONSTRUCTION & PRESSURE TANKS	LUMP	LUMP		.	
1180	SPV.0105 SPECIAL 04. ONSITE WASTEWATER TREATMENT SYSTEM	LUMP	LUMP		.	
1190	SPV.0105 SPECIAL 05. TELEPHONE SERVICE, MADISON SWEF	LUMP	LUMP		.	
1200	SPV.0105 SPECIAL 06. ELECTRICAL SERVICE, MADISON SWEF	LUMP	LUMP		.	
1210	SPV.0105 SPECIAL 07. STATIC SCALE SYSTEM	LUMP	LUMP		.	
1220	SPV.0105 SPECIAL 08. WEIGH-IN-MOTION SYSTEM	LUMP	LUMP		.	
1230	SPV.0105 SPECIAL 09. COMMUNICATIONS TOWER	LUMP	LUMP		.	
1240	SPV.0105 SPECIAL 10. ELECTRICAL SERVICE SWEF SIGNS	LUMP	LUMP		.	
1250	SPV.0105 SPECIAL 11. SWEF BUILDING, GENERAL CONSTRUCTION	LUMP	LUMP		.	
1260	SPV.0105 SPECIAL 12. SWEF BUILDING, PLUMBING	LUMP	LUMP		.	
1270	SPV.0105 SPECIAL 13. SWEF BUILDING, HEATING & VENTILATING	LUMP	LUMP		.	

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			DOLLARS	CTS	DOLLARS	CTS
1280	SPV.0105 SPECIAL 14. SWEF BUILDING, ELECTRICAL	LUMP	LUMP			.
	SECTION 0001 TOTAL					.
	TOTAL BID					.

**PLEASE ATTACH ANY ADDENDA OR
SCHEDULE OF PRICES HERE**